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CANMET
ATMOSPHERIC RECIRCULATING FLUIDIZED BED COMBUSTION PILOT PLANT CONCEPTUAL DESIGN STUDY
FINAL REPORT

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ABSTRACT

This report covers the conceptual design, budget cost and scheduling of a pilot-scale test facility for Atmospheric Recirculating Fluidized Bed Combustion (ARFBC), compiled in response to the Department of Supply and Services (DSS) Contract No. 05081-00240.

With the approval of DSS, Monenco entered into an agreement with Pyropower Corporation of San Diego, California for a design study of the combustor and cyclone. Ancillary equipment was then sized and, where possible, budget prices obtained from established manufacturers.

Part 3 of this report contains a discussion of designs, methods and alternatives for the main components of the rig. In particular various cooling designs and the handling of fuels and ash were examined.

The layout of equipment was based on an area designated for this rig in Canmet's laboratory at Bells Corners, Ottawa.

The study concludes that it is possible to accommodate the equipment within the prescribed area, although the available height will necessitate detailed examination of the building structure in designing the cooling systems.

A detailed material list of equipment has been compiled and a budgetary cost estimate and schedule drawn up. These conclude that the rig could be manufactured, delivered and installed in a period of twelve months at an approximate cost of $1.28 m, using proven designs and established manufacturers.

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PART 1

TERMS OF REFERENCE

1.1 INTRODUCTION

In Canada, various sources of unreactive and byproduct fuels exist, some major types being:

- Fluid coke (a byproduct of fuel oil upgrading plants)
- Oxidized western Canadian coals
- Coal washery rejects

Due to the location of these fuels, the necessity of designing special boiler plants to burn them and also economic factors, much of this fuel is unused and even involves disposal costs for industry.

The EMR Canmet Laboratories have identified the need for a pilot combustion rig to provide data which would lead to demonstration or industrial scale plants utilizing these fuels. Fluidized bed combustion appears to lend itself to this application, due to its lower temperature of combustion, enhanced sulphur capture, non-critical fuel sizing and increased residence time. In particular, the Recirculating Fluidized Bed method offers greater turbulence and residence time compared to bubbling bed designs. An initial test burning of a sample of Tar Sands fluid coke, in an atmospheric recirculating fluidized bed in Finland, confirmed the potential of this technology to burn unreactive fuels efficiently.

Based on this and other investigations, Canmet decided to carry out a design concept study, including budget costs and scheduling, of a pilot test facility for Atmospheric Recirculating Fluidized Bed Combustion (ARFBC).

1.2 SCOPE OF WORK

On 31st March 1982, the Department of Supply and Services (DSS) issued a contract to Montreal Engineering Company, Ltd., (Monenco) for the "Conceptual Design of Atmospheric Recirculating Fluidized Bed Combustion Research Facility" (ARFBC Facility), allocating Contract No. 05Q81-00240 for this purpose. The contract defines the scope of work as follows:

"Task 1 The Contractor shall, in consultation with Scientific Authority (SA) and an established designer or manufacturer of recirculating fluidized bed combustors, select a preferred size and heat input capacity for a pilot-scale atmospheric recirculation fluidized bed combustor, select a preferred means for removing a variable quantity of heat from the combustor and select a preferred means for reducing the temperature of the flue gas stream to a level suitable for final particulate removal by means of a bag filter.

Task 2 On the basis of the selections made in Task 1, the Contractor shall write short specifications for the combustor and all major ancillaries including but not limited to fans; fuel and limestone feeders; materials handling equipment for fuel, limestone and ash; cyclone; bag filter; flue gas removal; material storage facilities; instrumentation and controls. The Contractor shall submit the specifications to the SA for review.

Task 3 The Contractor shall prepare a conceptual plant design and layout for the pilot facility and thereby establish the overall space requirements. He shall endeavor to locate all components within an area 6 m x 6 m, and within the minimum reasonable head room. He shall also determine the total service requirements for water, electricity and compressed air.

Task 4 The Contractor shall prepare a brief description of a preferred control system for the facility, including a logic diagram and a list of control components.

Task 5 The Contractor shall prepare a list of components and materials required for the facility, as comprehensive as possible considering the conceptual nature of the design.

Task 6 The Contractor shall prepare a budgetary cost estimate for the facility, broken down in terms of design, procurement of purchased items, fabrication and erection.

Task 7 The Contractor shall prepare a bar chart schedule showing the design, procurement, manufacturing, construction and testing phases for each of the major components and steps in the complete project.

Task 8 The Contractor shall assemble all the information generated in Tasks 1 through 7 into a final report, and shall submit 10 typed copies, together with the appropriate drawings, lists and charts, component specifications, source etc. to the S.A."

As Task 1 stipulates that established technology was to be used, Montreal Engineering, with the approval of DSS, entered into an agreement with Pyropower Corporation, of San Diego, California, who market Pyroflow recirculating fluidized bed combustion equipment based on the design of the Ahlstrom Corporation of Finland.

PART 2

BASIC DATA

2.1 OPERATING ENVIRONMENT

For the purposes of the report it is assumed that the ARFBC facility is to be installed in the Canmet Laboratories at Bells Corners, Ottawa.

Various test rigs are operated by Canmet at their present facility, including a fluidized bubbling bed and a pulverized coal firing rig. The operating philosophy for these rigs was reviewed as Canmet wish to adopt a similar philosophy for the ARFBC facility.

The following design conditions were therefore adopted:

- 1000 hours maximum yearly operation.
- 8 hour typical test run (day shift).
- Test runs manually supervised, normally with two operators and one engineering supervisor.
- Manual preparation of materials prior to test run by Canmet in a separate part of the laboratory.
- Materials (fuel, limestone, ash etc.) delivered, stored and disposed of in drums, or bags.
- Lifting facility limited to 4.5 tonnes, 9m hook height.
- Maximum height below roof structure 10.9m.
- Floor area approx. 6m x 6m.

2.2 FUELS

Two fuels were selected as design criteria, representing the maximum and minimum anticipated heating values. These fuels are:

(i) Maximum Calorific Value design fuel - Tar Sands fluid coke

(ii) Minimum Calorific Value design fuel - Coal washery rejects, (Sterco #3 heavy medium cyclone reject)

Fuel Analysis (As Received Basis):

Proximate Analysis	Fluid Coke (i)	Coal Washery Rejects (ii)
Moisture %	3.6	20.1
Volatile Matter %	7.0	N/A
Fixed Carbon %	83.0	N/A
Ash %	6.4	53.5
HHV kcal/kg	7,472	1637
Ultimate Analysis		
Ash %	6.4	53.5
Sulphur %	6.8	0.1
Hydrogen %	1.2	3.76
Carbon %	79.5	17.76
Nitrogen %	1.2	0.38
Oxygen %	2.5	24.50
Unaccounted %	2.4	-
Vanadium ppm	1700	-
Ash Fusion Temperature °C	1370	1280

Fuel Size and Distribution

Size/Fuel (by weight)	(i) Fluid Coke	Typical Solid Fuels*	(ii) Coal Washery Rejects
50mm/ 38mm	-	1%	-
38mm/ 25mm	-	1.5%	-
25mm/ 19mm	-	1.5%	-
19mm/ 13mm	-	3.0%	3.04
13mm/ 6mm	-	20.0%	20.20
6mm/ 3mm	-	24.5%	28.34
3mm/ 16 mesh	-	17.0%	16.90
16 mesh/28 mesh	-	10.0%	9.52
28 mesh/100 mesh	100.00	21.5%	22.00
100 mesh/0		-	-

(* Assumed Distribution)

Limestone

Various limestones will be tested in the combustor. Limestone size is -6mm.

2.3 SITE DATA AND UTILITIES

Site Elevation	65m, above mean sea level.
Cooling Water	207 kPa gauge min., 27°C max. (Municipal Supply)

Compressed Air	Laboratory plant air system 620 kPa gauge, .047 m^3/s (Assumed)
Electricity	600V/3 phase/60HZ

PART 3

METHODOLOGY AND ALTERNATIVES

3.1 GENERAL

The two basic aims of this report; arriving at a conceptual design and providing budget costs, necessitate the adoption of certain design parameters, followed by investigation and preliminary definition of equipment.

The heart of the ARFBC rig is the combustor/cyclone/recirculation loop. A specification was compiled in order to summarize the intent and design of this loop, from which Pyropower, of San Diego, California produced a design study report (Section 4.1).

Pyropower own and operate four fluidized bed pilot scale combustors, all of which have been operating in the bubbling bed mode to date. One of these units is shortly to be modified to a recirculating bed mode of operation. The operating parameters established by Pyropower for the Canmet ARFBC are based on data drawn from Pyropower's Californian experience, and also from operational records of pilot and full scale plants in Finland, which were designed by Ahlstrom, whose designs are marketed by Pyropower in North America.

Plates 1 to 5, which are included in Part 4 of this report, show the process flows, layout of equipment, the cooling loop, the control logic diagram and a panel layout.

3.2 COMBUSTOR/CYCLONE

A meeting was held at Pyropower's offices in San Diego, California between Pyropower, Canmet and Monenco during which the combustor size of 406mm I.D. was agreed upon. The combustor/cyclone is described in Pyropower's report (Section 4.1).

Canmet require a maximum operating temperature in the combustor of 1100°C, which exceeds the 1000°C normally used by Pyropower/Alhstrom. Their test rigs are constructed from stainless steel pipe with external insulation and electric heating ignition coils. This type of construction was not considered suitable for the 1100°C maximum temperature requirement.

It was decided, therefore, to adopt a refractory lined combustor design. A similar design is normally used in the cyclone and no changes were necessary in this component.

The two existing pilot scale fluidized bed combustion test rigs, at Canmet and Queen's University, are rectangular in section, fabricated in carbon steel and refractory lined. The possibility of Pyropower adopting a rectangular combustor design was also discussed but was not implemented for this conceptual design study as:

- the cylindrical design is closer to the Pyropower experience;

- at this scale the performance differences between cylindrical and rectangular designs are not considered to be significant;

- the cylindrical design is simpler to manufacture.

At a detailed design stage this question could be re-examined although the rectangular cross sectional design would probably involve extra costs in engineering and fabrication.

Pyropower Corporation do not themselves manufacture any equipment, and subcontract fabrication based on their designs and specifications. Therefore, a possibility exists of fabricating the combustor components in Canada. For budgetary purposes it is assumed that import duties saved would approximately equal extra costs incurred.

The combustor cooling system consists of bayonet tubes inserted down into the combustion chamber. The longest bayonet tube is 5.8 m and, with the combustor length of 6.2 m, gives a combined length of 12 m. As the clear height below the roof is only 10.9 m, it is evident that a roof aperture is required in order to remove the longest bayonet tube, even if it were possible to mount the combustor on the floor level.

The simplest method of removing the bayonet tubes is included in the conceptual design and consists of an enclosed structure on the roof, located over the combustor, with a tackle for lifting the tubes. This arrangement would allow withdrawal as well as adjustment of the tube insertion depth, but would involve either working from the enclosure or installing a wire and pulley system for the task. Lowering the combustor enhances the degree of adjustability but withdrawal from the chamber of the longest tube would still require the enclosure on the roof.

The conceptual design adopts a cooled feeder to withdraw the bed drain material, as explained in Section 3.5. The height below the combustor could be significantly reduced by adopting a combination of ash removal schemes. However, as the combustor plenum is removable, a space of at least 1 m is desirable below the combustor for attachments and working space.

Although this minimum height would be acceptable, the basic problem is only alleviated, not solved. Consideration has not been given at this stage to the use of a pit below the combustor because of factors such as buried obstructions, services and drainage. It was also agreed by Canmet that floor penetrations should be excluded from the conceptual design. The overall height problem hinges on the use of a longitudinal bayonet tube heat removal system in the Pyropower design. Although the scope of this work precludes a redesign of the combustor itself, the following approaches may be investigated at the detailed design stage, in order to eliminate roof penetration or an enclosure on the roof. It should be noted that adoption of these or similar combustor modifications would probably involve extra costs.

Essentially, the longitudinal bayonet tubes could be replaced by tubes inserted through the side of the combustor. In examining this alternative, the following points should be considered:

- The maximum effective length of each tube would be achieved by insertion upwards and at an angle through the combustor wall, e.g., an insertion angle of 70° provides almost a threefold increase in tube length within the combustor compared to a horizontal tube.

- This arrangement would require at least 18 tubes to provide the same surface area of tube within the combustor. It is possible that even this is a low estimate, due to different flow conditions prevailing around the bayonet tubes from the top of the combustor compared to those inserted through the shell.

- The number of shell insertions could probably be reduced by adopting a combination of bayonet tubes of reduced length through the top of the combustor plus tubes through the combustor shell.

It may be possible to design a method of dismantling these tubes, although their operating conditions would necessitate careful consideration of the means of joining sections in order to avoid seizure. If a satisfactory method was found, the roof penetration might not be required.

All of these suggested modifications to the Pyropower basic design may, on detailed investigation, prove to be impractical. One further possibility, which would not involve a redesign, would be to enclose the whole test rig in a separate building. As the present layout includes all the necessary structural steel for carrying the rig and its associated access platforms and stairs, modification of the structure and the addition of external cladding would not represent a large additional cost. This alternative would depend on space being available near the existing laboratory and the additional cost would vary with the type of enclosure selected.

3.3 IGNITION BURNER

Various methods are used for lighting a fluidized bed combustor, ranging from building a fire in the bed to electrical heating of the combustor. Canmet specified either a light oil or propane burner for combustor light-up. Light-oil burners would require a new pumping installation while propane facilities are presently in use at the Canmet Bells Corners Laboratories. Therefore, a propane ignition burner was selected.

Pyropower included in their report an estimate of 469 kW for the hourly heat liberation rate required by the ignition burner. This is approximately 65% of the combustor rating. In response to Monenco's query of this figure, Pyropower provided the following assumptions on which the estimate was based:

- Sensible heat gain of refractory.
- Sensible heat gain of start-up bed material.
- Sensible heat gain of vessel.
- Sensible heat gain of fluidizing gas.
- External heat loss (by radiation).
- Ignition temperature of 650°C.
- Superficial gas velocity of 1 m/s.
- Ignition in 1 hour.
- Combustor physical parameters.

Monenco made their own estimate of the required heat liberation rate based on similar assumptions, although it is considered that only the surface layer of the refractory would require heating and that the bayonet tubes are being cooled. This analysis resulted in a rate of 293 kW, which would result in an appreciably smaller burner.

A bubbling bed pilot scale combustor, presently operating at Queen's University, Kingston, Ontario is fitted with a propane ignition burner. It was learned that this burner is rated at 70% of the combustor rating. As this rating is comparable with Pyropower's estimate, a 65% rated burner has been included in the budgetary cost as a conservative figure for estimating purposes.

This burner rating analysis led directly to the question of the integrity of the bayonet tubes, in particular the lower ends, during operation of the ignition burner. It is assumed that the flame will not directly impinge upon these tubes and that dilution of the propane flame will be sufficient to reduce the maximum temperatures to a level commensurate with a reasonable tube life.

From experience at Queen's University, where the propane ignition burner operates in a somewhat similar environment, these assumptions appear to be reasonable, as at Queen's the tubes can be as close as 230mm to the ignition burner.

If it were possible to completely retract the bayonet tubes from the combustor during the operation of the ignition burner, then a more rapid heating could be applied and the tubes would not be exposed to this undesirable environment. This retraction, however, involves the roof penetration discussed in the previous section of this report.

3.4 MATERIALS HANDLING

Handling systems are required for the two components of the combustor bed content, namely solid fuel and limestone. The anticipated size, distribution and flowrates of these materials are markedly different and call for different handling methods. While the limestone presents no particular problems, the presence of relatively large lumps of coal in some fuels makes a mechanical system preferable to a pneumatic one.

The main factors affecting the systems are:

- Small size of the equipment.
- Variable quantities and categories of materials.
- Space limitations.
- Dust containment.
- Ability to fill bins prior to test run.

As stated in Part 2-BASIC DATA, it is assumed that the materials will be prepared in another part of the laboratory and sufficient quantities will be transferred to the bins for a test run of 8 hours duration.

The simplest solution to transferring coal to the rig would be to disconnect the coal bin, lift it to the preparation area by means of the laboratory crane and return it by the same means after filling. The capacity of the coal bin has been determined on the basis of an 8 hour test run on coal washery products, the fuel with the lowest calorific value. At this capacity and the present equipment sizing, it appears that insufficient headroom would be available under the crane to remove the bin, as shown on Plate 2. At a later stage, once detailed sizing of layout of equipment is completed, this solution may prove to be viable.

At present, however, a removable hopper and bucket elevator are included. Two hoppers are recommended to allow rapid filling of the bin when necessary. Normally, one charge of the higher calorific value fuel would be required for a test, but the washery products would necessitate two or more charges.

The limestone, or other similar material under test, is to be pre-screened to -6mm and would therefore be suitable for vacuum conveying directly from storage drums. This method is capable of rapidly transferring the material required for the test, depending on the power employed. The selected flowrate of 0.8 kg/s will allow the bin to be filled in about 30 mins., freeing staff for other duties before the test. The capacity of the blower could also be available for other purposes such as bed drain material transport and vacuum cleaning.

During the conceptual design Canmet identified that the limestone size may be increased to -8mm from -6mm. No significant changes to conceptual design are envisaged due to this change and therefore further consideration of such a change would be required during the detailed design stage.

The conveying of the coal and limestone to the combustor is achieved by screw feeders, a transfer conveyor which mixes both components, and feeding chutes into the upper and lower ports on the combustor. The chutes are jacketed to permit water cooling, if necessary, and also have connections to the combustor secondary air source. As the source tapping is downstream of the air measurement, any air used from this source to prevent clogging of the material will not interfere with the control/data systems.

Metering of the quantities of coal and limestone will be accomplished by means of load cells beneath the bins and feeders; these will provide total weight of charge, flowrate and quantity of fuel burned.

Consideration was given to the use of weighfeeders for metering and totalizing the materials to the combustor. A weighfeeder which would be suitable for these tasks was identified but has not been adopted at present. Use of a weighfeeder may be viable, although the precise tolerances and capability of these devices may be degraded when handling widely varying materials with relatively high surface moisture content. There may be problems with material adhering to the feeders, leading to inaccurate flowrate measurement. Further investigation would be required, but the quotation received is included in Section 4.3 for information purposes.

The conceptual design also assumes that the combustor back pressure could be present up to the bins, as the whole conveying system is enclosed. To prevent backflow of gases, slide gates will be fitted at the bins and at the conveyor end of the combustor feed chutes. At the detailed design stage, consideration could be given to installing a rotary valve after the transfer conveyor to prevent pressure back-up. The valve would entail either additional height of the bin or lowering of the top combustor feed port and is not included at this stage.

One further material requires handling, namely sand or some other unreactive material, which is introduced as a "rapid" initial charge into the bed prior to the limestone in order to ensure a clean bed for SO_2 tests. As this sand charging is intermittent, it has been assumed that a bed charging bin may be lifted directly from the preparation area and discharged onto the feeder conveyor which will discharge into the combustor via one of the feed chutes.

During this conceptual design, discussions took place with Canmet on the possibility of reducing the maximum size of fuel to be burned to 19 to 25 mm, in order to enhance the air transportation properties of the fuels. This reduction in maximum fuel size is not included at this stage. However, the possible advantages of such a modification are:

- Filling of coal bin could be achieved by using a vacuum system similar to the limestone filling cycle. The same blower could be employed for both tasks as it is unlikely that filling of both limestone and coal bins would be required at the same time.

- An alternative method of transporting the fuel from the metering conveyors into the combustor could also be employed. Pneumatic transportation could feed fuel to any of the available fuel inlet ports in the combustor, rather than the two ports in the conceptual design layout. In addition, with proper design and hook-up of tubing/piping, the same vacuum blower may be suitable to provide the transport air or, alternatively, the air could be tapped from the F.D. fan.

The above discussion only itemizes the equipment/system advantages of reducing the fuel size to the combustor. These advantages/options have to be balanced against any loss in operational data obtained from the proposed facility due to such a modification of the design parameters. Another factor that must be considered is the extreme abrasiveness of fluid coke. While this might not present a problem on the test rig, it has caused severe erosion of conveying tubes in existing plants.

3.5 PROCESS COOLING SYSTEMS

The calculated total heat rejection is up to 698 kW/h, which must be removed in order to:

- control the temperature level in the combustor
- lower the flue gas temperature before the dust collecting equipment
- control the temperature of the byproducts for safe handling

Three distinct cooling services are therefore required for the combustor, flue gas and bed drain respectively. The basic aim of the first two are to achieve constant temperature for combustion control under wide variations in load, fuel feed and excess air.

The largest cooling service is for the combustor and amounts to approximately 400 kW. It is accomplished by means of bayonet tubes inserted into the combustor through which water is circulated under outlet flow control; the flow being adjusted to suit the combustor temperature. A coarse adjustment of the cooling rate is also available by varying the cooling surface area within the combustor by insertion or retraction of the bayonet tubes.

Cooling of the flue gas is achieved by a water glycol heat exchanger tube bank of carbon steel tubes mounted in staggered rows in a down pass duct. Although this item will be specifically designed and fabricated for the rig, the configuration is that of a heat exchanger bank with provision being made for removal of an entire section to allow variation in the surface area for the purposes of a particular test.

Due to the varied fuels to be tested in the rig, a significant variation occurs in bed drain quantity (referred to as bottom ash in Pyropower's report). This is due to the sulphur and ash contents of the fuels varying over wide ranges. The fluid coke is relatively high in sulphur with medium ash content, while coal washery rejects are low in sulphur but very high in ash. The coal washery rejects case has the maximum effluent rate of 0.027 kg/s.

The bed drain effluent is a mixture of bottom ash and limestone in varying proportions depending upon the fuel burned. It is discharged at approximately 870°C and, apart from small samples for analysis, is disposed of in drums. Various methods of reducing the temperature prior to collection were considered. These methods are:

(i) Pneumatic disposal inside a water jacketed pipe to a cyclone. Discharge from the cyclone into drums.

(ii) Collection by gravity in a water cooled buffer hopper prior to discharge into drums.

(iii) Cooling in a small chamber blown with the combuster secondary air prior to distribution into combuster.

(iv) Cooling and flow rate control using a cooled feeder mechanism.

The above methods have the following advantages/ disadvantages:

	Advantages	Disadvantages
(i)	Potential of significant reduction in height below combustor (up to 1.4m)	- High temperature flow control valve required (probably specially designed for purpose).
(ii)	Lack of complexity Low cost	- Due to lack of agitation preferential cooling is likely without long residence time. Long residence time implies tall hopper and so may raise combustor. - Special design/fabrication necessary.

(iii)	Transfers heat back into process (Advantageous on a boiler)	- Specialized design/development necessary.
(iv)	Provides flow control	- High capital cost
	May be inclined upwards to ease height restraints	- Required height of 2.3m below combustor.
	Commercially available	
	Experience of use on other fluidized beds	

Certain combinations of the above methods could be employed should this be necessary. For instance, if reduction of height below the combustor is considered essential, then a combination of methods (i) and (ii) could be employed. A loop seal, similar to that employed by Pyropower on the recirculation seal in the combustor/cyclone arrangement, could be employed as a flow control device, together with a filtered vent and control valve to exhaust any transport air. In such an arrangement the bed drain material could be pneumatically transported to the cooler which could be located remotely from the combustor and thus reduce overall height. For the conceptual study these variations have not been pursued. Two manufacturers of cooled feeders were identified as having equipment and experience with similar applications. These are:

Manufacturer	Equipment
1. Joy Manufacturing (Kitchener, Ontario)	Holo-Flite Mode S710

2. Bethlehem Steel Porcupine Processor
(Control & Metering, Toronto) Model 1P1203JT

As the Porcupine Processor is shorter than the Holo-Flite this has been used in the conceptual design and in the budget cost estimate.

The existing Canmet rigs use the municipal water supply for cooling and discharge the effluent into the drainage system. We understand that the location and size of the new ARFBC rig would present difficulties with the quantity of water required. Therefore a closed loop system, incorporating an air-cooled heat exchanger, has been included in the design at this stage. Limits on available space lead to the assumption that this heat exchanger will be mounted on the roof of the building, which in turn means that a glycol/water system would be necessary to prevent freezing problems. However, the loop will be opened on a regular basis to allow adjustment to the number and insertion length of the bayonet tubes in the combustor, which could result in spillage of the glycol/water solution.

A simple water filled system would be possible if the cooler could be installed inside the building with ducting and inlet/outlet louvres to the exterior. This scheme would necessitate large wall/roof penetrations and additional ducting. When the final location of the rig within the building is decided a suitable ducting route for this scheme may merit further investigation, obviating the use of the glycol/water fluid.

3.6 DUST COLLECTION/ASH RE-INJECTION

Industrial dust collectors are available in many sizes and types. A two hopper collector utilizing an automatic air pulse jet device for cleaning the bags has been used for the budgetary estimate. This collector has integral legs and comes as a complete unit. In sizing the dust collector the most severe service conditions were assumed.

In normal operation i.e. no ash recycle, the capacity of these hoppers would be adequate to hold the flyash from an 8 hour test.

If removal of the ash during the run is desired, this may be accomplished by connecting a drum with a clamped lid to the discharge valve via a flexible hose, as shown on Plate 1. By opening the valve ash will discharge by gravity into the drum. The same procedure may also be employed to empty the hopper after shutdown. Normally the ash generated from a test run can be removed in two drums.

Should ash recycling back into the combustor be required, then one or more hopper outlets can be connected to the outlet of a variable speed rotary valve. The speed of the valve may be manually adjusted to set a feed rate. The ash will pass through the valve and discharge into a pipe that is pressurized to approximately 28 kPa gauge with air. This air will pick up the discharged ash and carry it into the combustor through the bottom inlet port. In this manner combustion tests with flyash being recycled can be performed. The flowrate of ash back to the combustor can be measured by diverting the flow into a sample drum for a timed period. This drum will be provided with a filtered vent to allow the transport air to discharge. After the timed diversion of recycled ash, the flow to the combustor is re-established and the drum is weighed to provide a measure of the recycle ash flow rate.

The dust collector could also be made available with a single hopper and two outlet connections complete with rotary valves. The advantages of this option may be considered in the detailed design phase.

3.7 CONTROL PHILOSOPHY

The object of the control system is to control the feedrate of fuel/air and limestone to operator set predetermined quantities. Various ratios are set by the operations staff in accordance with the quality of the feed materials, the basic operator set points being:-

- coal/air ratio
- cross limiting ratio
- combustion air/total air ratio
- limestone/coal ratio

The efficiency of combustion is determined from measurements of CO_2, O_2, SO_2, pressure, temperature, combustibles in ashes, CO loss etc.

The proposed system is a microprocessor based controller such as a Westinghouse 1500 or Micom P200 and all input signals could be made available for Canmet data logging.

Due to possible coal feeder failure or difficulties with maintaining consistant combustion on some fuels, Canmet requested that the ignition burner be operable after the ignition phase.

Operation of the ignition burner is normally interlocked with the completion of the purge cycle. It is considered feasible to allow manual operation of the ignition burner providing the combustor temperature is above the volatiles ignition temperature, without prior operation of the purge cycle. Further investigation of such a feature is not included in the conceptual design and would be required in the detailed design phase.

PART 4

EQUIPMENT SPECIFICATIONS

4.1 PYROPOWER REPORT

The Pyropower Design Study is included and presents the basic operating philosophy and combustor/cyclone arrangement plus materials/energy balances for fluid coke/coal washery rejects firing at maximum combustor ratings.

It should be noted that all data in the report, both for fluid coke and washery rejects, is based on maximum design conditions of 7.0 m/s superficial combustor gas velocity with 25% excess air, which corresponds to 1100°C operation. The normal duty of the combustor would be at 5.18 m/s gas velocity corresponding to 1000°C operation, with up to 50% excess air.

The Monenco combustor specification is attached as a guide to the Pyropower terms of reference. Monenco's letter of 15th of April to Pyropower and the minutes of the meeting on 28th April 1982 are also included.

CANMET Pilot Plant

Design Study

by

Pyropower Corporation

May 1982

1. Pyropower Design Description

1. PYROPOWER DESIGN DESCRIPTION

The Pyropower circulating-bed combustor design for the CANMET Pilot Plant includes a refractory-lined furnace, a bayonet tube heat exchanger for combustor heat removal, a refractory-lined hot cyclone collector, and a non-mechanical pneumatically controlled solids recirculation loop. These components are shown schematically in Figure 2.1, which depicts the layout of the combustor system.

1.1 Furnace - The furnace is a refractory-lined carbon steel pipe with an outside diameter of 42 inches and a wall thickness of 0.250 inch. An internal layer of high-temperature insulation and a protective second layer of erosion-resistant castable refractory give the furnace an inside diameter of 16 inches. The height of the furnace is approximately 20 feet and is designed to accommodate a retractable bayonet tube heat exchanger. The furnace incorporates all necessary penetrations for primary and secondary combustion air, fuel and limestone feeds, and recirculating solids from the hot cyclone. Twelve (12) additional penetrations including one viewing window are included for cost estimate purposes.

1.2 Combustor Heat Removal - A bayonet tube heat exchanger is provided for combustor heat removal. It is constructed of 1-inch Schedule 40 stainless steel pipe and consists of two 17-foot lengths and two 19-foot lengths. The bayonet tubes are retractable and give a maximum total heat transfer area of approximately 25 square feet in their fully inserted positions. The bayonet tubes are inserted into the furnace through penetrations in the top head assembly.

1.3 Hot Cyclone Collector - The hot cyclone has a 50-inch diameter barrel and is approximately 9.5 feet high. The barrel, outlet cone, and inlet and outlet gas pipes are refractory-lined to give a maximum metal skin temperature of 93°C (200°F) at a coincident maximum internal gas temperature of 1,100°C (2,012°F). The vortex finder is unlined Hastelloy X pipe.

Hot flue gas enters the cyclone at approximately 800° to 1,000°C (1,100°C maximum) with entrained ash, limestone, and unburned solid fuel.

The solids are separated from the hot flue gas and are gravity fed to the combustor furnace by means of a downcomer pipe and a non-mechanical pneumatically controlled solids recirculation loop. Differential thermal expansion in both legs of the loop is accommodated by a low-temperature bellows.

1.4 Combustor Controls - Pyropower suggests the following procedure for controlling the combustor, but emphasizes that design flexibility permits the exercise of other options which may better suit CANMET's specific objectives and requirements.

The total forced draft (FD) fan output is controlled to give the required superficial gas velocity in the combustor. This flow is adjusted to allow for additional combustion air from the blower that supplies purge gas to the non-mechanical solids recirculation loop.

The fuel flow rate is controlled to maintain a given percentage of excess air in the gas leaving the hot cyclone. Fuel can be injected either at the non-mechanical solids recirculating loop, at the bottom of the combustor, or at the middle of the combustor. The limestone flow rate is controlled to maintain the SO_2 concentration in the flue gas at acceptable limits. Limestone is injected with the fuel.

Combustor temperature is controlled by the bayonet cooling tubes. Both the flow of coolant (sub-cooled water) and the length of the tubes inside the furnace are adjustable.

2. Combustor Layout

3. Process Flow Diagram

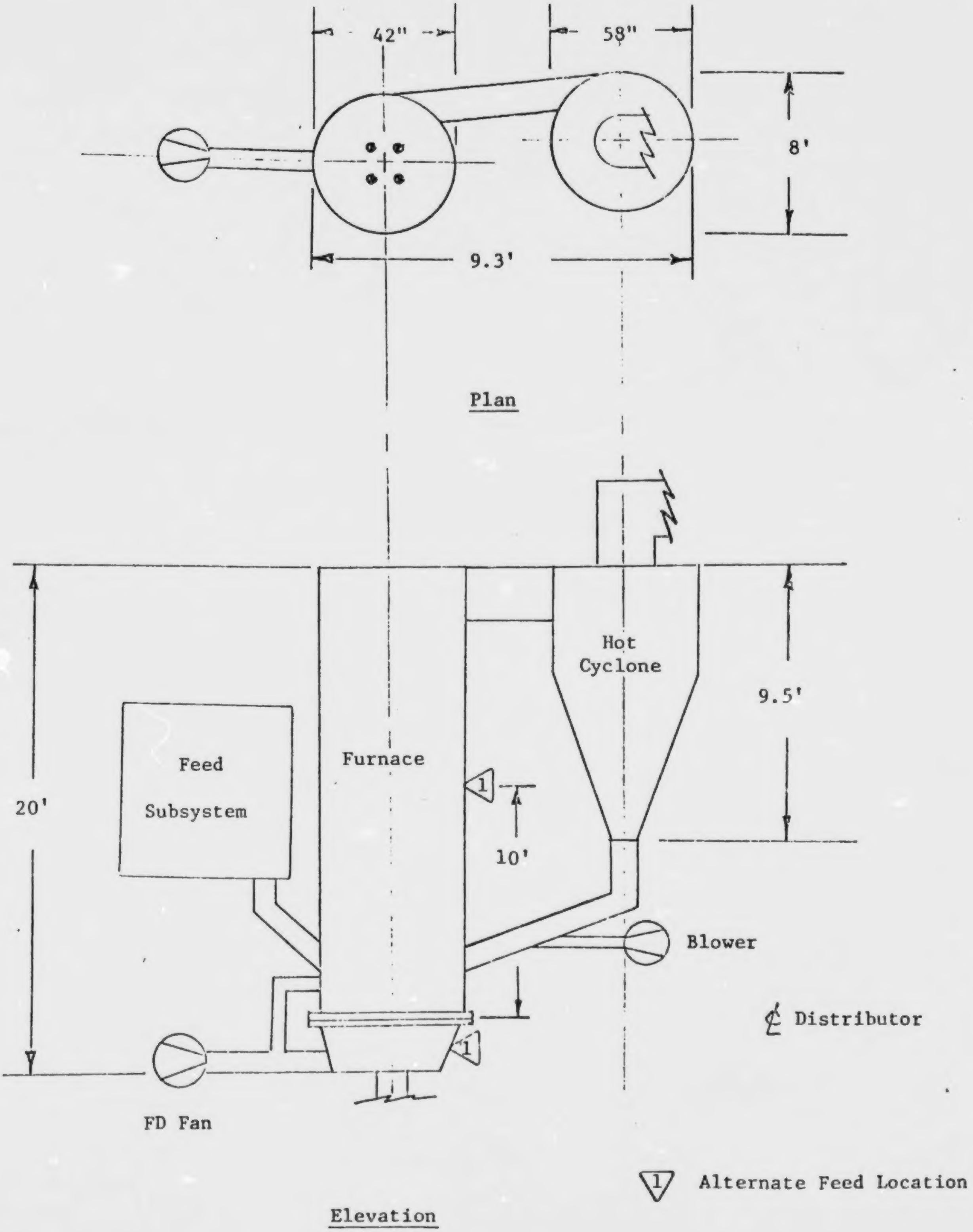

42"
58"
8'
9.3'
Plan
Hot Cyclone
9.5'
Feed Subsystem
Furnace
1
20'
10'
Blower
℄ Distributor
1
FD Fan
1 Alternate Feed Location
Elevation

Fig. 2.1 CANMET Pilot Plant Combustor Layout

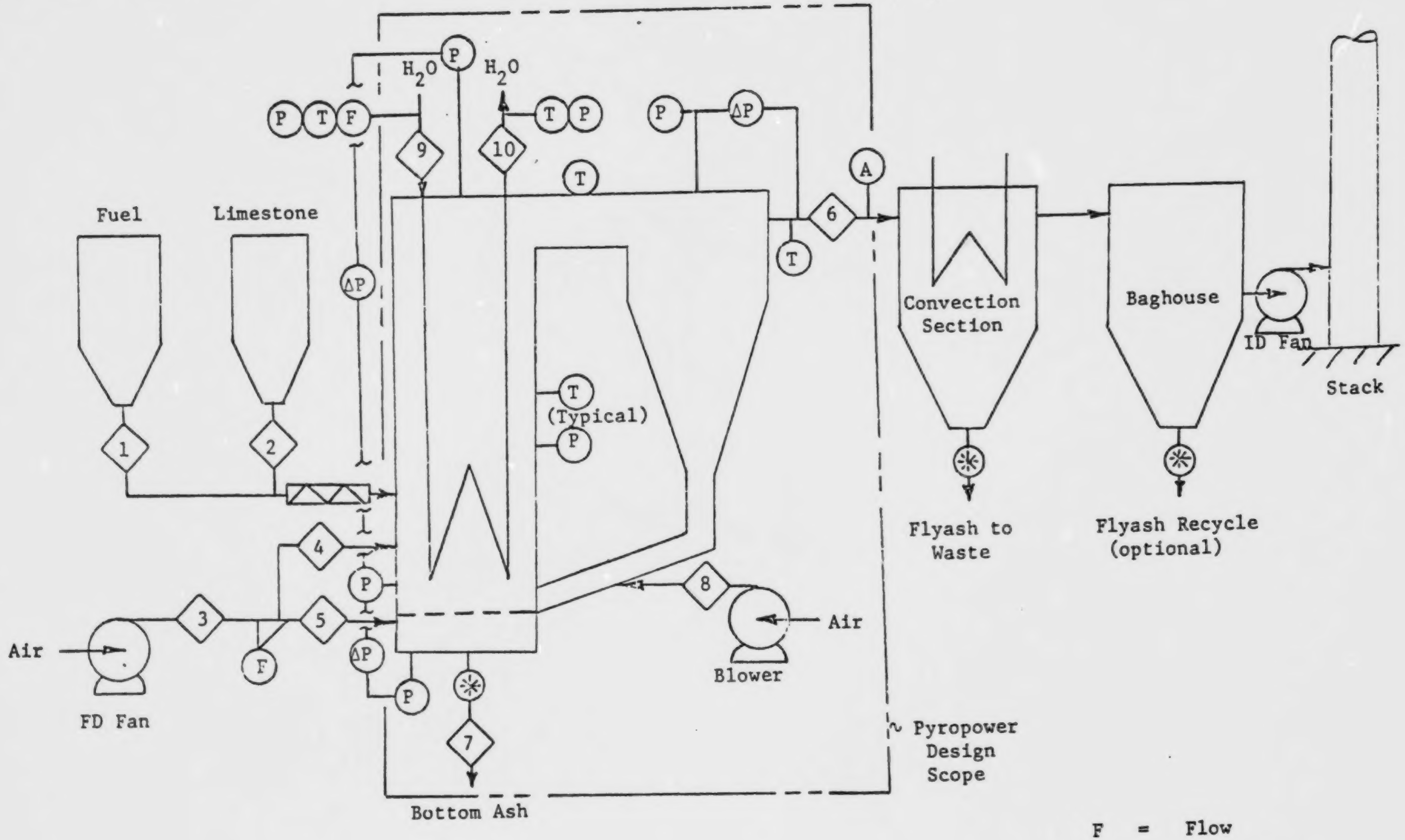

Fuel
Limestone
1
2
3
4
5
6
7
8
9
10
Air
FD Fan
F
P
T
ΔP
A
H_2O
H_2O
(Typical)
Air
Blower
Bottom Ash
Convection Section
Flyash to Waste
Baghouse
Flyash Recycle (optional)
ID Fan
Stack
~ Pyropower Design Scope

Fig. 3.1 Process Flow Diagram

F = Flow
T = Temperature
P = Pressure
A = Analysis
◇XX = Stream Numbers correspond to Material & Energy Balances (Section 4)

4. Material and Energy Balances

MATERIAL AND ENERGY BALANCES - TARSANDS FLUID COKE

Stream No.	◇1	◇2	◇3	◇4	◇5	◇6	◇7	◇8	◇9	◇10
Stream	Fuel Fired	Limestone	Forced Air	Secondary Air	Primary Air	Flue Gas	Bottom Ash	Blower Air	Water	Water
Flow [1]										
kg/s	0.023	0.012	0.266	0.140	0.126	0.303	0.005	0.014	1.73	1.73
lb/hr	184	94	2110	1111	999	2402	39	112	13,763	13,763
Temperature										
°C	21	21	21	21	21	858	871	21	10	66
°F	70	70	70	70	70	1577	1600	70	50	150
Pressure										
kPa (abs)	101.4	101.4	114.3	109.9	114.3	101.0	101.4	153.2	446.3	446.3
inches of water	0	0	52	34	52	-1.5	0	208	50 psig	50 psig
Density [2]										
kg/m3	800	1600	1.36	1.31	1.36	0.326	1360	1.82	1,000	981
lb/ft3	50 [3]	100 [3]	0.0846	0.0811	0.0846	0.0202	85 [3]	0.1134	62.4	61.2
Volumetric Flow [2]										
m3/s	N/A	N/A	0.196	0.108	0.093	0.936	N/A	0.008		
ft3/min.	N/A	N/A	416	228	197	1982	N/A	16.5		
U.S. gal/min.	N/A	N/A							27.5	28.0
Heat Content										
kW	724	(1)	5.86	2.9	2.6	293	3	0.3	73	475
10^6 Btu/hr	2.47	(0.005)	0.020	0.010	0.009	1.00	0.012	0.001	0.25	1.62

[1] At 7.0 m/s (23 ft/s) superficial gas velocity in combustor.

[2] At actual temperature and pressure.

[3] Approximate or typical values.

[4] Radiation heat losses (cyclone + combustor) = 2.47/2.06 X 32,351 = 38,790 Btu/hr.

MATERIAL AND ENERGY BALANCES - COAL WASHERY REJECTS

Stream No.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Stream	Fuel Fired	Limestone	Forced Air	Secondary Air	Primary Air	Flue Gas	Bottom Ash	Blower Ash	Water	Water
Flow [1]										
kg/s	0.083		0.221	0.116	0.105	0.270	0.027	0.012	0.853	0.853
lb/hr	659	0	1750	921	829	2145	215	92	6771	6771
Temperature										
°C	21		21	21	21	860	871	21	10	66
°F	70		70	70	70	1580	1600	70	50	150
Pressure										
kPa (abs)	101.4		114.3	109.9	114.3	101.0	101.4	153.2	446.3	446.3
inches of water	0		52	34	52	-1.5	0	208	50 psig	50 psig
Density [2]										
kg/m3			1.36	1.31	1.36	0.305	1360	1.82	1,000	981
lb/ft3			0.0846	0.0811	0.0846	0.0189	85	[3] 0.1134	62.4	61.2
Volumetric Flow [2]										
m^3/s	N/A		0.16	0.09	0.08	0.893	N/A	0.006		
ft^3/min	N/A		345	189	163	1892	N/A	13.5		
U.S. gal./min.	N/A						N/A		13.5	13.8
Heat Content										
kW	569		5.0	2.6	2.4	283	19	0.3	35.2	235
10^6 Btu/hr	1.94	0	0.017	0.009	0.008	0.966	0.066	0.001	0.12	0.80

[1] At 7.0 m/s (23 ft/s) superficial gas velocity in combustor.

[2] At actual temperature and pressure.

[3] Approximate or typical values.

[4] Radiation heat losses (cyclone + combustor) = 1.94/1.43 X 25,335 = 34,371 Btu/hr.

5. Sizing Data: Pertinent Design Data

CANMET Pilot Plant
Tarsands Fluid Coke

Sizing Data for Ancillary Equipment

(a) Fans	Capacity(2) (acfm)	Head (in. w.g.)
F.D.	416	52
I.D.	810(1)	-20
Blower	16.5	208

(1) Calc. @ 14.0 psia, 340°F, M.W. = 30.3.

(2) Add 50-80% margin to increase excess air for other fuels.

(b) Baghouse dust loading

	SCF	ACF
Dust loading, gr/CF (60% flyash, 40% bottom ash)		
No baghouse recycle	14.4	8.9
Recycle @ 2/3 baghouse flyash	43.2	26.7

(c) Bed drain rate:

Average: 98 lb/hr

Maximum (empty combustor with 4-ft. static bed in 30 minutes): 630 lb/hr.

(d) Feeder:

Coke:	184 lb/hr
Limestone:	128 lb/hr
Total:	312 lb/hr

(e) Bayonet tubes:

Max. heat duty: 1.37×10^6 Btu/hr (402 kW)

(f) Cyclone ΔP: 2.20" w.g.

(g) Ignitor Rating: 1.6×10^6 Btu/hr (469 kW)

CANMET Pilot Plant
Coal Washery Rejects

Sizing Data for Ancillary Equipment

(a) Fans	Capacity(2) (acfm)	Head (in. w.g.)
F.D.	345	52
I.D.	772(1)	-20
Blower	13.5	208

(1) Calc. @ 14.0 psia, 340°F, M.W. = 28.4.

(2) Add 50-80% margin to increase excess air for other fuels.

(b) Baghouse dust loading

	SCF	ACF
Dust loading, gr/CF (40% flyash, 60% bottom ash; no baghouse recycle)	37.0	22.4

(c) Bed drain rate:

Average:	358 lb/hr
Maximum:	630 lb/hr (based on emptying combustor with 4-ft. static bed in 30 minutes)

(d) Feeder:

Coal Washery Rejects:	659 lb/hr
Limestone:	0

(e) Bayonet tubes:

Max. heat duty: 0.68×10^6 Btu/hr (200 kW)

(f) Cyclone ΔP = 2.20" w.g.

6. Cost Estimate / Delivery Schedule

Budgetary Cost Estimate: $300,000 ±20% f.o.b. Ottawa, Canada loading dock

Included: Materials, fabrication, packaging, shipping and engineering of the following Pyropower system components:

1. Combustor furnace
2. Furnace heat removal surface (bayonet cooling tubes)
3. Hot cyclone
4. Non-mechanical solids recirculation loop

Not Included: Instrument penetrations, controls and instrumentation, site erection and import tariffs or duties.

Delivery Schedule: 6 months after Contract award date.

MONENCO

A.R.F.B.

COMBUSTOR SPECIFICATION

PURPOSE

Pilot scale test combustor for research into the combustion of fuels. It is required that the pilot scale combustor be representative of full scale units in order to provide meaningful research data from its use.

Any limitations of the combustor, resulting from its small scale, shall be clearly itemized by Pyropower in order that design modifications or methods of use may be examined in order to provide a pilot plant which is able to simulate combustion in full scale units of such a design.

TERMINAL POINTS

The following are considered the terminal points for the Pyropower scope of equipment design. However, design data for equipment beyond these terminal points may well be within the Pyropower scope of work.

a. Connections for primary and secondary air at combustor.

b. Connection at combustor for ash removal.

c. Connection at combustor for fuel/limestone feed.

d. Freeboard Cooling tubes connections.

e. Flue Gas connection - exhaust from Cylone Separator.

f. Bed Cooling Connections (if any).

DESIGN CRITERIA

The combustor will be used primarily to test the burning of Unreactive Solid Fuels in a recirculating fluid bed. Examples of such fuels are given below:

(Analysis on As Received Basis) Proximate Analysis	Tarsands Fluid Coke	Byron Creek (Lvb) Low Volatile Bituminous	Line Creek (Lvb)
Moisture%	2.5-4.0	4.86	2.0-2.5
Volatile Matter %	7.0	25.6	19.8
Fixed Carbon %	83.0	53.28	61.5
Ash %	6.4	16.2	18.7
HHV (Btu/lb)	13,450	11,597	11,810

Ultimate Analysis	Fluid Coke	Byron Creek	Line Creek
Ash %	6.2-6.4	16.21	18.7
Sulphur %	6.6-6.8	0.53	0.3
Hydrogen %	1.48	3.91	3.8
Carbon %	79.5	67.51	69.8
Nitrogen %	1.2	1.00	0.89
Oxygen %	2.5	5.94	6.51
Vanadium ppm	1700		
Nickel ppm			
Sodium ppm			
Ash Fusion Temp°C	1370		

The above are typical examples of unreactive fuels which would be burned in the combustor. There is no limitation to these particular fuels and the combustor should possess the maximum flexibility possible. Also such parameters as Vanadium content or ash content can vary appreciably from the above i.e. examples of 2500 ppm vanadium or up to 50% ash content are known.

Examples of high Sulphur coal are as follows:

Proximate Analysis (As received)

	Devco Coal	Minto Coal	
Moisture %	0-10	2 max	Dry Basis
Volatile Matter %	33.5	30.7	
Fixed Carbon %	47.0	47.3	
Ash %	16-22	22 max	

Ultimate Analysis

	Devco Coal	Minto Coal
Carbon %	64.2	62.6
Hydrogen %	4.0	4.3
Sulphur %	5.5	9 max
Nitrogen %	1.0	0.8
Ash %	19.3	22.0
Oxygen %	6.0	1.3
HHV Btu/lb	11,500	8700
Ash Fusion Temps min.	1175°C (2150°F)	1000°C (1832°F)

COMBUSTOR SIZE

If possible, the maximum combustor size should be restricted to 18 in X 18 in., while maintaining proper equipment design.

OPERATION

It is envisaged that the pilot plant will operate up to 1,000 hours per year in typical 8 hour runs.

LIGHT-UP OF COMBUSTOR

Either a light-oil gun or propane gun is envisaged for light-up of the combustor. Pyropower to specify heat requirement/duration and the light-up system will be specified by MECo.

HEAT REMOVAL - COMBUSTOR

A variable method of removing heat from the combustor is required. This may be accomplished by removable water cooled tubes inserted into the combustor or by other means to be proposed by Pyropower, which is acceptable to Canmet. The heat removal method shall be capable of removing 0-70% of the heat released in the combustor.

SPACE AVAILABLE

The combustor and all auxiliary equipment (except F.D. and I.D. fans) shall be sized so that it can be located into a space 6m X 6m by 6m high (19.7 ft. X 19.7 ft. by 19.7 ft. high). This area is free of obstructions and serviced by an overhead crane.

COMBUSTOR

One face of the combustor will be required to be free of connections and obstructions so that the user may locate additional penetrations on this wall for testing purposes.

It is envisaged that the combustor will be constructed as a gas tight steel casing with a refractory lining. Pyropower shall specify type of construction to be employed. A removable bottom section of the combustor is desirable in order that the bed charge may be readily dumped.

The combustor shall be designed for operation at bed temperature up to 1100°C and shall include windbox, distributor plate, primary cyclone and reinjection system design to operate at bed temperature, means for reinjecting secondary air at various locations above the distributor plate, view ports, and be complete with an ample number of ports suitable for withdrawing gas and solid samples, introducing temperature and pressure probes. The combustor shall have a connection for bed drain and Pyropower shall identify parameters necessary to design an adequate bed drain cooling system.

FAN SIZING

The F.D. and I.D. fans will be sized for 70% excess as a maximum design firing rate.

Attachment 1

MONTREAL ENGINEERING COMPANY, LIMITED

CORBLOC, 80 KING STREET, ST. CATHARINES, ONTARIO
CORRESPONDENCE:
P O Box 1540, St. Catharines, Ontario L2R 7J9
Tel (416) 688-9263
Telex: 061-5219
Cables: "Monenco"

15 April 1982

File: DSS 7914-9

Pyropower Corporation
P.O. Box 81608
San Diego, California
U.S.A.
92138

Attention: Mr. H. Yip

Re: CANMET Pilot Scale, Atmospheric Recirculation-Fluidized Bed Combustor Feasibility Study

Further to your telex of 9 March 1982 and MECo telex 15th March 1982, we are pleased to confirm our acceptance of your proposal.

The following scope of work is to be provided by Pyropower for a fixed fee of five thousand U.S. dollars ($5,000.00)

1. Select a preferred size and heat input capacity for a pilot-scale circulating fluid bed combustor suitable to be located within a 6M X 6M area.

2. Define design criteria for the pilot CFBC facility and provide support budgetary-type material and energy balances. The design criteria shall also consider the range of fuel characteristics to be tested.

3. Conceptually design a flexible CFBC pilot facility which can accommodate a range of fuel types and provide dimensional envelope type layouts.

4. Provide a process flow diagram for the pilot CFBC with some indication of instrumentation.

5. Provide cost estimate for the Pyropower supplied components and estimate of delivery time.

. 2

Note: CFBC (Circulating Fluidized Bed Combustor) equivalent to A.R.F.B.C.

HALIFAX • FREDERICTON • MONTREAL • OTTAWA • TORONTO • ST CATHARINES • CALGARY • EDMONTON • VANCOUVER

The products of the above tasks will be:

a) Materials Balance
b) Energy Balance
c) Layout (plan and elev) of combustor
d) Sizing data: Pertinent Design Data
e) Process Flow Diagram
f) Cost Estimate/Delivery Schedule
g) Descriptive information of the Pyropower Design.

The envisaged schedule for the above work is that the Pyropower products will be available in the MECo, St. Catharines Office by 1st June 1982. Please confirm that this date is acceptable to you.

Please direct all communications on this project to Mr. R.P. West in this office.

We look forward to working with your company on this assignment.

Yours very truly,

A. Dobson
Senior Vice President, Thermal

RPW/cr
cc: Mr. S. Detre
Mr. S. Marcou
Mr. R.P. West
Mr. A. Wyatt

Notes on Meeting at Pyropower Corp.

28th April/82

Attendance:

F. Friedrich, Canmet
D. Desai, Canmet
H. Yip, Pyropower
J. Rode, Pyropower
W. Rickman, Pyropower (part time)
R. West, MECo

1. The agenda telexed to Pyropower was essentially followed.

   Mr. F. Friedrich of Canmet introduced the Canadian fuels situation and Canmet's role. The existing Canmet bubbling bed facility was described as well as the envisaged usage of a Recirculating Bed test facility.

   Initial testing would be on Fluid Coke (mostly under 100 mesh in size) using a Fort MacMurry limestone as sorbent. Further work would be on unreactive coals (using a sand bed material) and such fuels as Washery Rejects.

2. Pyropower made a presentation of their experience and the Ahlstrom experience.

3. The Pyropower work scope was reviewed and clarified - as described in MECo letter dated 15 April 1982.

4. It was agreed that a combustor of a nominal I.D. of 16 inches would be adopted.

   As this size would be approximately 7 1/2m high, the height restriction of 6m was relaxed. It was recognized that the height requirement for the facility may be of the order of 10 1/2m. This will be reviewed by MECo/Canmet at a later date.

   The cyclone and combustor will be refractory lined and the cyclone will be similar in diameter to the combustor.

   Pyropower will design such that the balance point between F.D. and I.D. fans will be between the cyclone and the convective cooler.

   Two fuels were selected as maximum and minimum fuels respectively, for Pyropower to use in their design.

Maximum Fuel - Tarsands, Fluid Coke,

HHV = 13,450 Btu/lb.
(Details in combustor specification
and telex to Pyropower 19 April 1982).

Minimum Fuel - Sterco, #3 Heavy Medium
Cyclone Reject
HHV = 2,947 Btu/lb.
(See attachment for details).

To arrive at the design limestone ratio, it was agreed to use a 9% sulphur coal, sulphur capture down to 1.64 lb/MMBtu, assuming limestone with 50% Calcium Carbonate. The calcium/sulphur ratio will be set to 2.3.

Design velocity - 18 fps with margine to 23 fps (approx. 50% of air via distributor plate).

Bed Temperature - 1100°C max, 800-1000°C normal.

Combustor Cooling - Bayonett tubes from top of combustor.

Twelve additional penetrations will be included in combustor costs. (One to be a sizable window).

Fuel Feed - Pyropower recommend a screw feed for this size unit.

6. Pyropower confirmed that the required design data will be completed by 1st June 1982.
7. Mr. H. Yip, Pyropower and Mr. Friedrich, Canmet will be at the C.I.E. New Fuels Symposium in Calgary May 27 1982. It was suggested that R. West, MECo also attend and then the Pyropower progress could be jointly reviewed.
8. MECo provided Pyropower with two copies of the A.R.F.B. Specification.

Attachments

(a) Sterco, #3, Heavy Medium Cyclone Reject 3 pp's.

(b) Letter MECo to Pyropower, 15 April 1982.

RPW/lc

Fuel Characteristics Coal Washery Rejects

LUSCAR LTD.

PROJECT: Sterco

SAMPLE: #3, Heavy Medium Cyclone Reject

DATE: September 8,1980

TABLE 1: ANALYSIS OF HEAD SAMPLE

		As-Rec'd Basis	Air-Dry Basis	Dry Basis
Moisture %		20.08	5.11	--
Ash %		53.54	63.57	66.99
B.T.U./lb.		2,947	3,499	3,687
Calories/gm.		1,637	1,944	2,048
Carbon %		17.73	21.05	22.18
Hydrogen %		3.76	2.37	1.90
Nitrogen %		0.38	0.45	0.47
Oxygen %		24.49	12.44	8.34
Sulphur %:	(Sulfate)	*	*	*
	(Pyritic)	0.03	0.04	0.04
	(Organic)	0.07	0.08	0.08

* Less than 0.01%

CYCLONE ENGINEERING SALES LTD.

LUSCAR LTD.

PROJECT: STERCO

SAMPLE: #3, Heavy Medium Cyclone Reject

DATE: September 8, 1980

TABLE 2: FUSIBILITY OF ASH

	Reducing Atmosphere °C	Oxidizing Atmosphere °C
Initial Deformation Temp.	1280	1290
Softening Temp.	1350	1360
Hemispherical Temp.	1395	1405
Fluid Temp.	1460	1480

LUSCAR LTD.

PROJECT: Sterco

SAMPLE: #3, Heavy Medium Cyclone Reject

DATE: September 8, 1980

TABLE 3: ANALYSIS OF SIZE FRACTIONS (DRY BASIS)

Size	Weight %	Ash %	B.T.U./lb.
3/4" x 1/2"	3.04	63.77	4,384
1/2" x 1/4"	20.20	61.89	4,136
1/4" x 1/8"	28.34	56.49 ✓	5,949
1/8" x 16 m	16.90	67.39	3,532
16 m x 28 m	9.52	69.81	3,181
28 m x 0	22.01	86.73	47
Total	100.00	67.57	3,565

CYCLONE ENGINEERING SALES LTD.

4.2 COMBUSTOR AUXILIARIES

421 IGNITION BURNER

A propane fired, high velocity gas ignition burner shall be furnished. The propane supply shall be provided by others either from an external system or from bottles. The burner design shall be such that 90% of the combustion is completed before the products enter the combustor central chamber. Air for combustion shall be supplied from the secondary air supply.

The burner shall be manually initiated and shall be furnished with a flame scanner, all necessary safety interlocks/trips, control valves and a dust tight control panel.

DATA SHEET

IGNITION BURNER

Fuel -	Propane
Air supply available -	Yes
Air pressure available -	13 kPa
Required heat output -	470 kW
Back Pressure on burner -	5 kPa (Approx.)
Inlet air temperature -	38°C max. -30°C min.
Controls required -	Packaged ignition burner controls including dust tight panel, Flame scanner with interlock, Spark plug ignitor for burner, complete with acessories to operate from 115V/60 Hz/1 phase power supply Control valves. Purge Cycle Control and interlock on burner trip. Manually initiated ignition of burner from panel with automatic safety trips/overrides.

TRECAN
The Canadian Combustion Company

TRECAN LIMITED
4540 DIXIE ROAD
MISSISSAUGA
ONTARIO
L4W 1N2
(416) 625-4030
TELEX: 06-961261

June 17, 1982

Montreal Engineering Company Limited
P.O. Box 1540
St. Catharines, Ontario
L2R 7J9

ATTENTION: Mr. R. P. West

Re: Your File DSS-7914-9

Gentlemen:

We are responding to your letter of June 4, 1982 regarding a (i) Flue Gas Cooler and (ii) an ignitor for the proposed fluid bed combustion syste you are studying. Our comments are to provide a conceptual design description and budget cost and these can be followed up with specific quotations at the proper time.

(i) Flue Gas Cooler

The arrangement we have decided to recommend for the air cooled option is shown on the sketch attached dated 82/06/17. We prefe to use a style with the flue gas inside the tubes to make tube cleaning easier than the reverse. We had to go to 2 passes on the flue gas to keep the height such that it would match the flu bed height. This means the cooled flue gas outlet is near the t but the duct to the baghouse inlet can be carbon steel.

To do the job within the 5 meter height available and with a single pass would involve the use of tubes under 1" dia., and we believe this may cause problems due to the dust.

The order of magnitude of cost for this cooler would be about $ 32-35,000, including the air fan.

If water were used, the cost would be 20-30% lower and the unit could easily fit into the 5 meter space.

......./2

(ii) Ignitor

This requirement is for a special version of one of our standard high heat release burners as shown in the HV burner sheet enclosed. The size would be a model 320. Special flanges would be used to allow for the back pressure. The valve train and other controls would be quite standard and your air supply pressure of 52" W.C. is adequate. We have supplied several of these fluid bed "ignitors".

The cost for the package including a local control cabinet would be about $ 12,000.

We hope the above comments are sufficient for your current needs. Call us if we can elaborate.

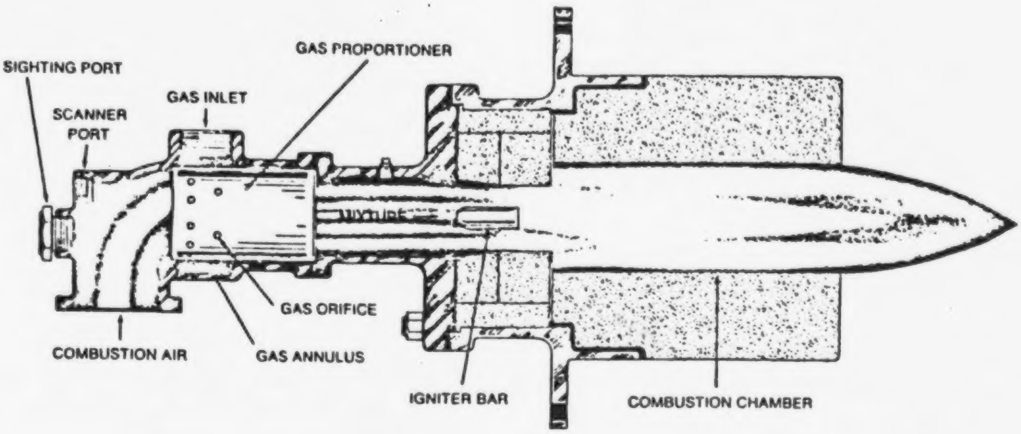
Yours very truly,

TRECAN LIMITED

W. K. Lombard, P. Eng.
President

WKL/lc

Encl's

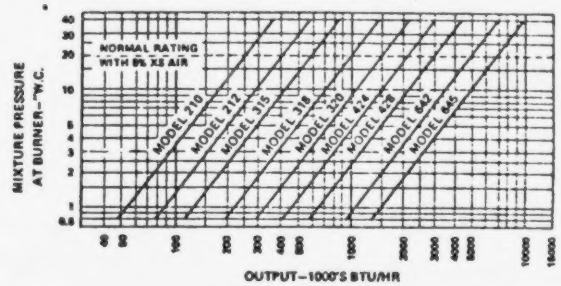

SIGHTING PORT
SCANNER PORT
GAS INLET
GAS PROPORTIONER
MIXTURE
GAS ORIFICE
COMBUSTION AIR
GAS ANNULUS
IGNITER BAR
COMBUSTION CHAMBER

HV GAS BURNER

The Compact Combustor –

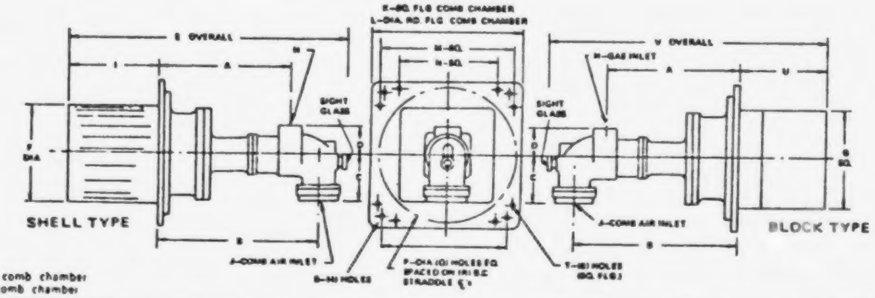
In the THERMAL HV gas burner the fuel is injected into the combustion air stream under pressure, providing a uniform mixture. Ignition occurs at the throat of the burner where a specially designed igniter bar is located. The igniter bar serves as a flame holder and constant source of ignition through the entire range of operation. Additional flame stability is provided by shoulder-type flame holders.

The flame is very short, with combustion over 90% completed within the burner block. Exit velocities are 300 to 500 ft./sec. in the standard units and up to 1500 ft./sec. for special applications. Only the highest grade materials are used and only refractory components are in contact with the high temperature gases.



GAS

Nine models available with the output ranges shown. A 5 to 1 turndown ratio is standard with each model, based on normal operation.


E OVERALL
I
A
H
SIGHT GLASS
F DIA.
C
D
SHELL TYPE
B
J—COMB AIR INLET
K—SQ. FLG COMB CHAMBER
L—DIA. RD. FLG. COMB CHAMBER
M—SQ.
N—SQ.
S—(4) HOLES
P—DIA (Q) HOLES EQ. SPACED ON (R) B.C. STRADDLE ℄'s
T—(8) HOLES (SQ. FLG.)
V OVERALL
H—GAS INLET
U
G SQ.
BLOCK TYPE

*9½ dia for sq flg comb chamber
11" dia for rd flg comb chamber

SERIES	A	B	C	D	E	F	G	H NPT	I	J NPT	K	L	M	N	O	P DIA.	Q	R	S DIA	T DIA	U	V
200	8 9/16	10⅝	3⅛	2	18⅝	4⅝	5	¾	6	1½	8	10	—	—	6½	7/16	8	9	9/16	—	6½	19¾
300	11⅝	14 5/16	4 7/16	2½	27 13/16	6¼	9	1¼	8½	2½	13½	13½	12½	7	—	⅝	8	12¾	—	9/16	8½	27 5/16
400	15 5/16	20 9/16	6⅛	4½	36 9/16	7¼	9	2½	10½	4	13½	16½	12½	7	—	⅝	8	15	—	9/16	10⅝	36 9/16
642	19 11/16	25 11/16	9	6 9/16	46⅝	*9 or 11	11½	3	14 9/16	6	—	21	15¾	10	17	⅞	8	19½	—	⅝	14 7/16	46¾
645	19 11/16	25 11/16	9	6 9/16	49 11/16	11	11½	3	17½	6	—	21	15¾	10	17	⅞	8	19½	—	⅝	14 7/16	46¾

TRECAN LIMITED
4540 DIXIE ROAD, MISSISSAUGA ONTARIO L4W 1N2.
Phone: (416) 625-4030 Telex: 06 961261

422 FANS

The draft/conveying equipment shall comprise the following items:

Fan #1 - Forced Draft Fan
    #2 - Induced Draft Fan
    #3 - Loop Seal Blower

Due to high heads, varying flows and duties, Roots type blowers are preferred for Fans #1 and #3, while Fan #2 shall be a turbo pressure blower. Normal operating conditions shall be as specified on the attached data sheet.

The F.D. Fan shall also provide air for recycle ash transport, when required. The tapping for this duty shall be downstream of the flow measuring device such that the measurement of the total air introduced into the combustor shall not be disturbed.

Flow from the Loop Seal Blower, Fan #3, shall also be measured to enable its contribution to the excess air to be evaluated.

Flow control for these units shall be by blowoff valves venting excess air to atmosphere via a silencer.

DATA SHEET

FORCED DRAFT FAN

Type of fan -	Turbo Blower or Rotary Lobe, positive displacement type
Mounting -	Fabricated Steel Base
Motor type -	TEFC 600V, 3 phase, 60 Hz
Drive -	Direct or V-Belt
Discharge head -	28 kPa
Flowrate (Inlet) -	0.27 m^3/s
Inlet temperature -	21°C
Accessories -	Inlet silencer with filter Discharge silencer Pressure Relief Valve (Rotary lobe blower only) Belt guard

Canadian Air Compressor Ltd.

Toronto: July 22, 1982
Quotation: #82067

Montreal Engineering Co. Ltd.
1 St. Paul Street
St. Catherines, Ontario

ATTENTION: Mr. Dick West

Subject: Roots Blower Package

Gentlemen:

Referring to your request for quotation of July 20, we are pleased to confirm pricing on the subject package.

1 only - Roots, model 409 RCS-JV, rotary lobe, positive displacement air blower having 5" N.P.T. horizontal air connections. The blower shall be mounted on a fabricated steel base complete with the following:

- 15 H.P., TEFC, 575/3/60, 1800 rpm, 254T frame electric motor (including slide base)
- V-belt drive group including belts and belt guard.

The following accessories are included but supplied loose, for mounting by others.

1 only - Universal, CCS-5, dry type, air inlet filter/silencer c/w weatherhood.

2 only - Universal, RD-5, chamber/absorptive inlet/discharge silencers.

1 only - Roots, PW-3, weighted type, pressure relief valve set @ 3½ PSI.

2 only - Roots, 5T/F, flexible, inlet/discharge connectors.

Total Price $8,585.00

(Subject to Attached Terms & Conditions)

Thank you very much for your inquiry. We trust you will find our proposal of interest.

If we can be of further assistance, please do not hesitate to call.

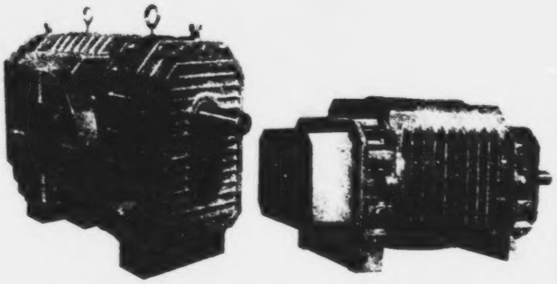
Yours truly,

per

R. Craddock
Sales Representative

In Toronto:
84 Queen Elizabeth Blvd., Toronto, Ontario, M8Z 1M5
Tel. (416) 251-5268, Telex: 06967618.

In Montreal:
1161 Autoroute Laval West, Chomedey, Québec,
H7L 3W3, Tel. (514) 334-5810, Telex: 0524550.

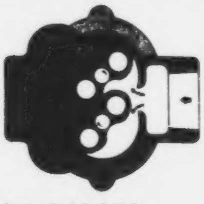


SPECIFICATIONS

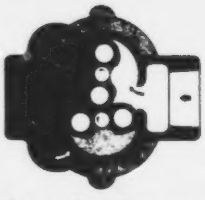
Roots RCS-J Rotary Positive Blowers

FRAMES 406J THRU 624J

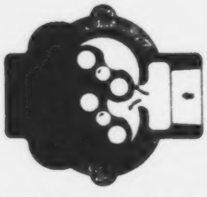
OPERATING PRINCIPLE



Incoming air (right) is trapped by impellers. Simultaneously, pressurized air (left) is being discharged.

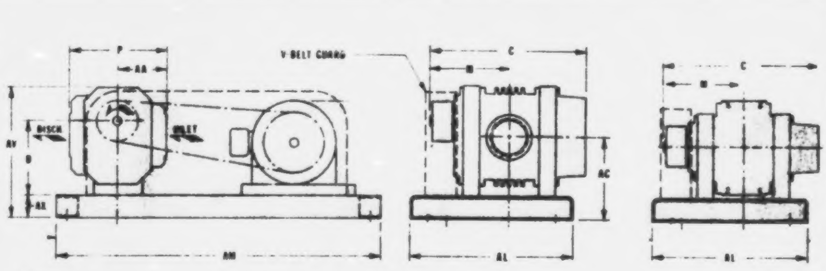


As lower impeller passes wrap-around flange, Whispair jet, (white arrow) equalizes pressure between trapped air and discharge area, aiding impeller movement and reducing power.



Impellers move air into discharge area (left). Backflow is controlled, resulting in reduction of noise relative to conventional blowers.

OUTLINE DRAWING & DIMENSIONAL TABLE



AF - INLET
AF' - DISCHARGE
AE - MINIMUM BLOWER SHEAVE DIA

NOTES: 1. Package weight is with largest motor frame size applicable, and is in pounds.
2. All specifications subject to change without notice.
3. All dimensions in inches.

FRAME SIZE	MOTOR FRAME	C	D	M	P	KEYWAY	AA	AC	AE	AF	AF'	AL	AL'	AM	AV	AX	V-BELT PKG. WT.
406J	256T-326T	20.38	11.25	10.44	14.50	375x.188	7.25	12.75	6.50	4"NPT	4"NPT	34.50	35.50	60.50	20.25	3.75	894
409J	256T-365T	23.38	11.25	11.94	14.50	375x.188	7.25	12.75	6.50	5"NPT	5"NPT	34.50	35.50	60.50	20.25	3.75	1095
412J	256T-404T	26.38	11.25	13.44	13.00	.375x.188	6.00	12.75	6.50	6"FLG	5"FLG	38.00	38.00	71.50	20.25	3.75	1235
418J	256T-404T	32.38	11.25	16.44	14.00	.375x.188	7.00	12.75	6.50	8"FLG	6"FLG	38.00	38.00	71.50	20.25	3.75	1335
616J	284T-445T	32.44	15.00	16.75	16.25	.500x.250	7.50	15.75	8.50	8"FLG	6"FLG	34.00	34.00	81.50	25.75	3.75	2349
624J	284T-445T	40.44	15.00	20.75	17.50	.500x.250	8.75	15.75	8.50	10"FLG	8"FLG	44.50	44.50	81.50	25.75	3.75	2549

BASIC MODEL DESCRIPTION

The Whispair line of rotary positive blowers has a proprietary design that reduces noise and power loss by utilizing an exclusive wrap-around flange and jet to control pressure equalization — eliminating rapid backflow of air/gas into the blower from the discharge area.

The basic model is designed with integral-shaft, ductile iron impellers having an involute profile. The alloy steel timing gears are taper mounted on the shafts, and cylindrical roller bearings are used. Both ends of the unit are splash oil lubricated. The casing, headplates, gear cover, and end cover are grey iron. Piston rings reduce the air leakage through the shaft openings in the headplates, and lip type oil seals prevent lubricants from entering air chamber. The top shaft is extended for drive on vertical units and the left hand shaft is extended for drive on horizontal units. After standard tests, the unit is painted, corrosion protection added, and it is boxed for shipping. Copies of instruction manuals are provided.

Available accessories include: baseplate for the blower and driver, v-belt drive with guard, coupling drive with guard, snubbers, driver, relief valves, inlet filter, and silencers.

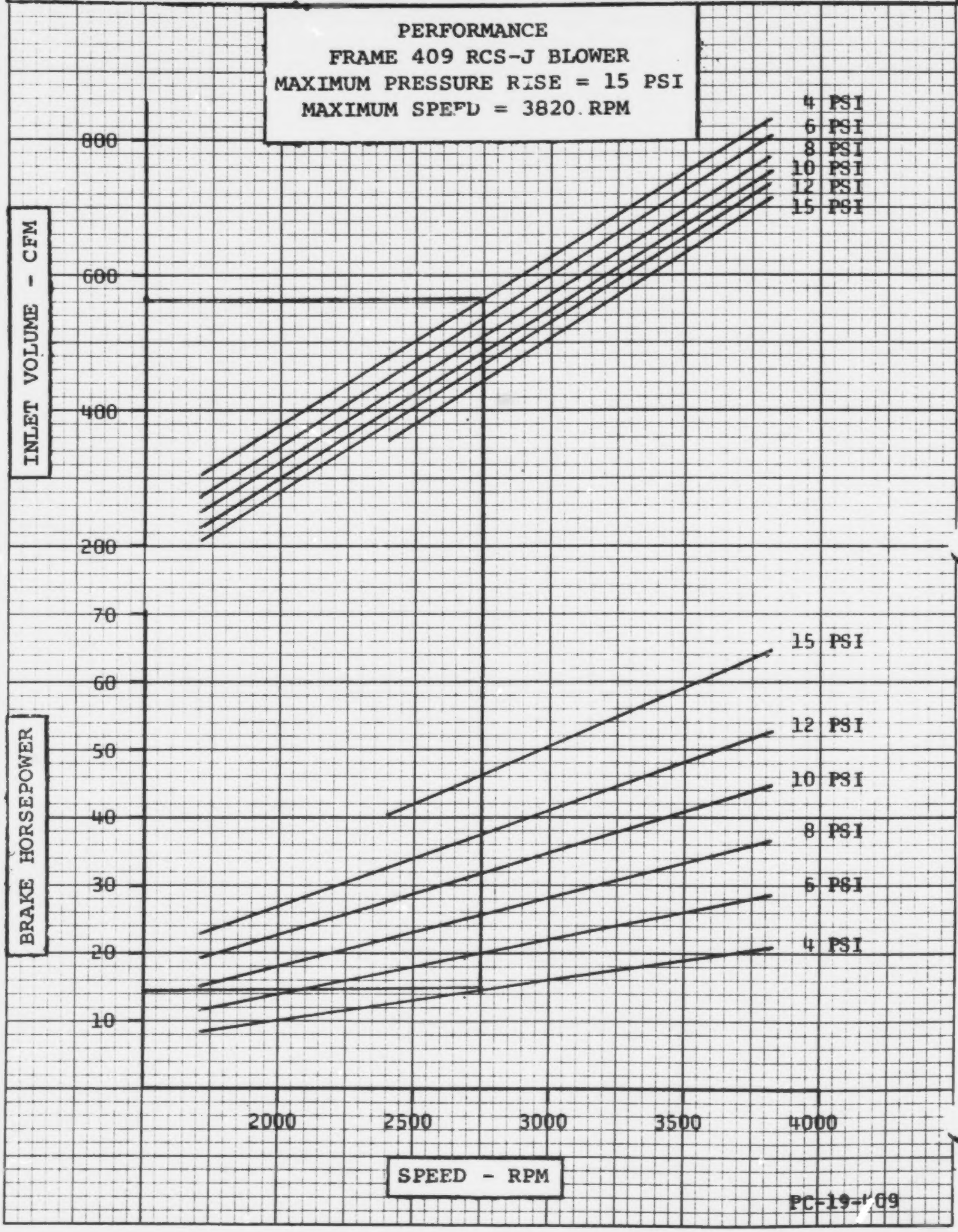
EVERY GROWING PLANT NEEDS ROOTS

INDUSTRIAL PRODUCTS DIV.
DRESSER INDUSTRIES, INC.
CONNERSVILLE, INDIANA 47331
PRINTED IN U.S.A.

PERFORMANCE BASED ON
INLET AIR AT 14.7 PSIA & 68° F
OCTOBER, 1979

PERFORMANCE
FRAME 409 RCS-J BLOWER

MAXIMUM PRESSURE RISE = 15 PSI
MAXIMUM SPEED = 3820 RPM



DATA SHEET

I.D.FAN

Type of fan -	Turbo Blower
Mounting -	Fabricated Steel Base
Motor type -	TEFC 600V, 3 phase, 60 Hz
Drive -	Direct
Differential head -	510 mm water gauge
Flowrate -	0.27 m^3/s at S.T.P.
Inlet temperature -	171°C
Accessories -	Variable pitch drive assembly Drilled inlet/outlet flanges

QUOTATION - PROPOSAL

Ref. No. M82-83
Page 1 of 2

CHICAGO BLOWER
CANADA LTD.

901 REGENT AVENUE WEST, WINNIPEG, MANITOBA, R2C 3A9, TELEPHONE 222-4216, AREA CODE 204, TELEX 07-57518
3295 MAINWAY DRIVE, UNIT 5, BURLINGTON, ONTARIO L7M 1A6 TELEPHONE 335-2717 AREA CODE 416 TELEX 061-8770

SUBMITTED BY Burlington Office
DATE May 28, 1982.
PROJECT Attn.: Mr. T. Wilson

TO Montreal Engineering Co.,
1 St. Paul St.,
St. Catharines, Ont.
L2R 7L2

ARCHITECT
ENGINEER
PROV. SALES TAX: Extra
TERMS N30
F.O.B. Winnipeg, Man.
FEDERAL SALES TAX: Extra

Dear Sir:

Confirming our telephone conversation of this afternoon, we are pleased to submit our quotation on the following equipment:

F. D. FAN

One (1) only Size 2T-10-32 Des. 15A Turbo Pressure Blower, SWSI, Arr. 4, direct drive, c/w:
- Drilled Flanged Inlet,
- Drilled Flanged Outlet,
- Motor mounting,
- Inlet Blast Gate,
- Inlet Silencer c/w Screen,
- 15 HP, 3/60/... 3600 RPM, TEFC Motor, Fr. 254T -

PRICE: $4,133.00

PERF.: 470 CFM @ 32.5 osi (56.3") 3500 RPM 10.8 BHP @ 70°F & S.L.

Sound Level: 83 DBa at 5'0"

I. D. FAN

One (1) only Size 2T-5-12 Des. 15A Turbo Pressure Blower, SWSI, Arr. 9, c/w:
- OSHA Belt Guard, mounted,
- Heat Slinger and Guard,
- Drilled Flanged Inlet,
- Drilled Flanged Outlet,
- Motor, drive and fan mounting onto Base,
- Integral Base c/w Motor Rails,
- Outlet Blast Gate,
- Variable Pitch Drive Assembly,
- 7½ HP, 3/60/..., 3600 RPM, TEFC Motor, Fr. 182T,
- Steel Wheel -

PRICE: $3,195.00

PERF.: 810 CFM @ 12 osi (21") 3500 RPM 5.4 BHP @ 70°F & S.L.
3.6 BHP @ 340°F & S.L.

....contd. Page 2...

Please Issue Your Purchase Order to: Chicago Blower (Canada)
c/o Our Local Sales Representative's Address. Thank You.

All of the Above is Subject to Terms and Conditions Shown on Reverse Side

SK-22-111-CN

DATA SHEET

LOOP SEAL BLOWER

Type of fan -	Rotary lobe, positive displacement
Mounting -	Fabricated Steel Base
Motor type -	TEFC 600V, 3 phase, 60 Hz
Drive -	V-Belt (with slide base)
Differential head -	52 kPa
Flowrate (inlet) -	0.008 m^3/s
Inlet temperature -	21°C
Accessories -	Inlet silencer with filter, Discharge silencer, Pressure Relief Valve, Belt Guard

Canadian Air Compressor Ltd.

Toronto: May 21, 1982
Quotation: #81679

Montreal Engineering Co. Limited
1 St. Paul Street
St. Catherines, Ontario

ATTENTION: Tom Wilson

Subject: Roots Blower Package

Gentlemen:

Referring to our telephone conversation of May 20, we are pleased to confirm pricing discussed at that time.

1 only - Roots, model 1702-J, rotary lobe, positive displacement air blower having 1½" N.P.T. air connections. The blower shall be mounted on a fabricated steel base complete with following:

- 2 H.P., TEFC, 575/3/60, 3600 RPM, 145T frame electric motor (including slide base)
- V-belt drive group including belt and belt guard.

The following accessories are included but supplied loose, for mounting by others.

1 only - Universal, CCS-1½, dry type, air inlet filter/silencer c/w weatherhood.

2 only - Universal, URB-1½ chamber type, inlet discharge silencer.

1 only - Roots, PW-1, weighted type, pressure relief valve set @ 8 PSIG.

2 only - Roots, model 1½T flexible connectors.

Total Price $1,935.00

(Subject to Attached Terms & Conditions)

Thank you very much for your inquiry. We trust you will find our proposal of interest.

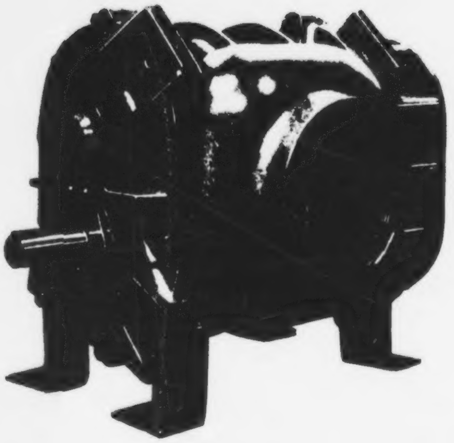
If we can be of further assistance, please do not hesitate to call.

Yours truly,

TWhite

per: R. Craddock
Sales Representative

In Toronto:
84 Queen Elizabeth Blvd., Toronto, Ontario, M8Z 1M5
Tel. (416) 251-5268, Telex: 06967618.
In Montreal:
1161 Autoroute Laval West, Chomedey, Québec,
H7L 3W3, Tel. (514) 334-5810, Telex: 0524550.

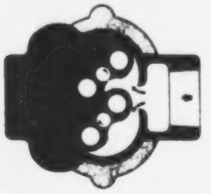


SPECIFICATIONS

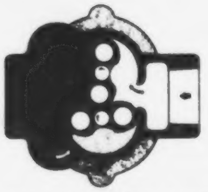
Roots Whispair Max Rotary Positive Blowers

FRAMES 1701 THRU 3514J

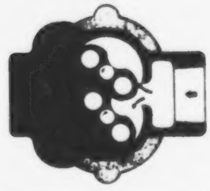
OPERATING PRINCIPLE



Incoming air (right) is trapped by impellers. Simultaneously, pressurized air (left) is being discharged.

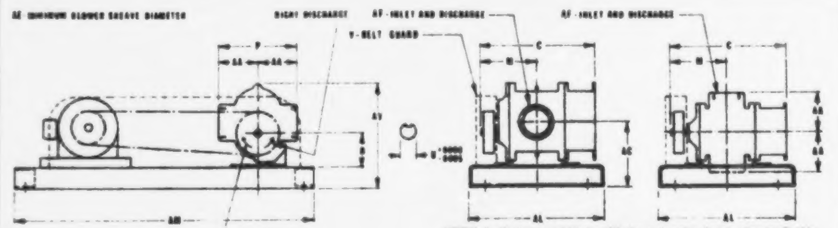


As lower impeller passes wrap-around flange, Whispair jet, (white arrow) equalizes pressure between trapped air and discharge area, aiding impeller movement and reducing power.



Impellers move air into discharge area (left). Backflow is controlled, resulting in reduction of noise relative to conventional blowers.

OUTLINE DRAWING & DIMENSIONAL TABLE



NOTES: 1. Package weight is with largest motor frame size applicable, and is in pounds.
2. All specifications subject to change without notice.
3. All dimensions in inches.
4. Sizes 1701, 1702, 1704 and 1707 do not have the Whispair feature.

FRAME SIZE	MOTOR FRAME	C	D	M	P	U	KEYWAY	AA	AC	AE	AF	AL	AM	AV	V-BELT PACKAGE WT.
1701	143T-184T	8.09	3.00	4.00	6.76	5625	125x.063	3.38	6.63	2.50	1.66	16.00	36.00	10.13	208
1702	143T-184T	9.13	3.00	4.50	6.76	5625	125x.063	3.38	6.63	2.50	1.5NPT	16.00	36.00	10.13	210
1704	143T-184T	11.00	3.00	5.44	6.76	5625	125x.063	3.38	6.63	2.50	2NPT	16.00	36.00	10.13	214
1707	143T-184T	13.31	3.00	6.63	6.76	5625	125x.063	3.38	6.63	2.50	2.5NPT	16.00	36.00	10.13	217
1702J	143T-184T	9.13	3.00	4.50	7.50	5625	125x.063	3.75	6.63	2.50	1.5NPT	16.00	36.00	10.13	227
~~1704J~~	~~143T-184T~~	~~11.00~~	~~3.00~~	~~5.44~~	~~7.50~~	~~5625~~	~~125x.063~~	~~3.75~~	~~6.63~~	~~2.50~~	~~2NPT~~	~~16.00~~	~~36.00~~	~~10.13~~	~~232~~
1707J	143T-184T	13.31	3.00	6.63	7.50	5625	125x.063	3.75	6.63	2.50	2.5NPT	16.00	36.00	10.13	237
2504J	145T-215T	11.38	4.00	5.38	9.50	7500	188x.094	4.75	8.00	2.50	2.5NPT	20.00	41.50	12.63	291
2506J	145T-215T	14.00	4.00	6.72	9.50	7500	188x.094	4.75	8.00	2.50	3NPT	20.00	41.50	12.63	303
2510J	145T-215T	17.38	4.00	8.38	9.50	7500	188x.094	4.75	8.00	2.50	4NPT	20.00	41.50	12.63	338
3505J	182T-256T	14.56	5.50	6.94	13.00	1.1250	250x.125	6.50	10.00	3.00	4NPT	29.00	46.00	16.06	491
3509J	182T-256T	18.25	5.50	8.75	13.00	1.1250	250x.125	6.50	10.00	3.00	5NPT	29.00	46.00	16.06	513
3514J	182T 256T	22.94	5.50	11.13	13.00	1.1250	250x.125	6.50	10.00	3.00	5NPT	29.00	46.00	16.06	551

BASIC MODEL DESCRIPTION

The Whispair Max Rotary positive blower has a proprietary design that reduces noise and power loss by utilizing an exclusive wrap-around flange and jet to control pressure equalization — eliminating rapid backflow of air into the blower from the discharge area.

The basic model consists of a grey iron casing and headplates, two ductile iron involute contoured impellers, taper mounted alloy steel timing gears, and ball bearings. The unit is oil lubricated at the gear end and grease lubricated at the drive end. It has lip oil seals, NPT thread connections (hose connections only on 1701), standard shaft sizes, and detachable feet. After standard tests the unit is painted, corrosion protection added and it is placed on skids or boxed for shipment. Instruction manuals are provided.

Available accessories include: a baseplate for the blower and driver, v-belt drive with guard, coupling drive with guard, flexible hose couplings, driver, relief valves, check valves, inlet filter, and silencers.

EVERY GROWING PLANT NEEDS ROOTS

423 SUPPORTS/LAYOUT

The combustor/cyclone and related equipment, as shown on Plate 2, shall be supported on a steel structure independent of the building. This structure shall also carry intermediate floors and access stairs.

The main support frame shall be located 1 m inside the centreline of the existing building walls on the north and west sides, in order to provide foundation clearance and access around the back of the rig. The layout shall be predicated on an available floor area of approximately 6 m x 6 m, with cantilevered walkways past the south face of the combustor/cyclone.

The combustor shall be supported approximately two thirds up the shell, and connected to the upper floor steel at elevation 6.35 m. The cyclone shall be bottom supported from the same floor steel so that the differential expansion of both units shall be approximately equal. The coal and limestone bins shall also be bottom supported from the same floor steel.

The fans shall be mounted on the north side of the rig at elevation 0.0 m and enclosed in a structure designed to reduce the noise level at the rig.

The exhaust stack shall be supported from the rig structure, and exit via a roof opening to a total height of 15 m above floor level.

The control cubicle shall be located on the first floor level close to the combustor.

4.3 FUEL/LIMESTONE HANDLING SYSTEM

431 FUEL HANDLING

The system shall consist of the following items:

- Coal Filling Hoppers
- Bucket Elevator
- Coal Bin
- Coal Feeder
- Transfer Conveyor

Each of the two 900 kg capacity coal filling hoppers shall be constructed in carbon steel, with a hinged top and a slide gate at the outlet. The hopper shall be supported and located on steelwork next to the bucket elevator when charging the coal bin. The hopper shall be fitted with lifting lugs so that it may be transported to the coal preparation area for filling.

The bucket elevator shall have a capacity of 3,500 kg/hr and an overall height of approximately 10m. The buckets shall be of mild steel construction.

The coal bin shall be of carbon steel plate construction with angle stiffeners. The cross section shall be rectangular with a sloped lower section and a clamped lid.

The coal screw feeder shall have a maximum capacity of 0.09 kg/s. A variable speed drive shall be included to adjust the fuel feed to the combustor.

Load cells mounted on flexible connections shall be furnished at the coal bin outlet and on the coal screw feeder to continuously measure fuel flowrate.

The transfer conveyor shall receive the coal from the coal screw feeder as well as limestone from the limestone feeder and deliver this material to feeder chutes supplying the top and bottom fuel inlets on the combustor. The transfer conveyor shall have a capacity of 0.126 kg/s and the limestone feeder a capacity of 0.016 kg/s.

Each feeder chute shall be of double wall construction fabricated in carbon steel. Connections shall be provided on the chute for air to assist material flow and water for cooling. Each chute shall be equipped with an isolating slide gate at the conveyor end.

DATA SHEET

BUCKET ELEVATOR

Materials -	Various coals and cokes Examples: Fluid coke: <2 mm mesh size Coal washery rejects: 19 mm max. with 28% < 28 mesh Other: Lumps up to 50 mm Moisture: up to 20%, as received.
Flowrate -	3500 kg/hr. +
Height -	10 m approx.
Motor -	TEFC 600 V/3 phase/60 Hz

DATA SHEET

COAL FEEDER

Materials -	Various coals/cokes
No. of top inlet connections -	Direct flanged connection to bottom of bin, over 80% of length
No. of bottom outlet connections -	One
Motor Drive -	TEFC, 600 V/3 phase/ 60 Hz
Type of Screw -	Tapered helicoid
Transmission -	V-belt, infinitely variable manually adjusted speed control
Trough -	Steel, flanged
Cover -	Steel, flanged
Length -	2.7 m
Flowrate -	0.045 kg/s
Material Properties -	Coal/cokes Max. lump size 50 mm (<1%) up to 75% < 60 mesh Average size 6 mm

DATA SHEET

TRANSFER CONVEYOR

Materials - Coal and limestone

No. of top inlet connections - Three

No. of bottom outlet connections - Two

Motor Drive - TEFC, 600 V/3 phase/ 60 Hz

Type of Screw - Helicoid

Transmission - V-belt/Constant Speed

Trough - Steel, flanged

Cover - Steel, flanged

Length - 3 m

Flowrate - 0.126 kg/s

Material Properties - Limestone - 6 mm
Coal: 50 mm max. (<1%)
to 100% $\leqslant$ 100 mesh
Average size 6 mm

1. T. Wilson
2. R. West

Sullivan Strong Scott

August 11, 1982

Monenco Ont. Ltd.
1 St. Paul St.,
St. Catherines, Ont.
L2R 7J9

Attention: Mr. R.P. West

Gentlemen:

We are pleased to submit Budget Prices covering three screw feeders, one 6"diameter collecting conveyor and one Model SCLC-2 bucket elevator, for handling coal, ash and limestone.

We sincerely hope the attached meets with your approval and look forward to hearing from you in the near future with regards to this coal feeding proposal.

Should you require any additional information on this or any other regard, please do not hesitate to contact us.

Yours truly,

SULLIVAN STRONG SCOTT LTD.

V. Piekny

V.Piekny
Sales

cc: D. Truman

VP/th

Bulk materials handling and processing systems. Vancouver Calgary Saskatoon Winnipeg Toronto Montreal Halifax.
Sullivan Strong Scott Ltd., 74 Wildcat Road, Toronto, Ontario M3J 2V4. (416) 661-5880 Telex 06-22813

Sullivan Strong Scott
Vancouver Calgary Saskatoon Winnipeg Toronto Montreal Halifax
Bulk Materials Handling and Processing Systems

QUOTATION

Reference
#20422

Date: August 11, 1982

To: Monenco Ont. Ltd.
1 St.Paul St., St.Catherines, Ont. L2R 7J9

Attention of: Mr. R.P. West

Subject: Budget Prices for Coal Feeding Proposal
3 Screw Feeders, 1 Collecting Conveyor
& 1 SCLC-2 Bucket Elevator

Gentlemen:

We are pleased to submit herewith our quotation covering our understanding of your requirements.

Sullivan Strong Scott Ltd.
Per: V. Piekny - Sales

UNIT #1 - COAL FEEDER

ONE 6"dia.? Screw Feeder Assembly 10'0"lg, inclined 0 to handle 14.5CFH of Coal, weighing 50lbs./cu.ft., consisting of:

1	9'10"lgth 6S412 6"dia. RH Sectional Conveyor Screw, 3/16"thk flights half pitch for 8'6", full pitch for 10" with 6"of bare pipe on discharge end, standard intermittently welded to a 2-1/2"dia. Sch.40 pipe
1	2'0"lgth CHP607 6"formed solid tubular trough, mat'l 3/16"thk
2	Trough Adaptor Flange Collars to join trough and customers bin
3	6"End flange gaskets, std black neoprene
1	Set flange gaskets, fitted, std black neoprene
1	Lot of assembly nuts and bolts
1	CSD610F 6"Flush end type Stub Discharge Spout less Slide, flanged & drilled, welded to trough
2	CEFT62 6"Tubular Trough End Plates for 2"dia. Shaft
1	CEB2RB 2"Roller Bearing Flange Block (Drive end)
2	CSW2 2"Waste pack seals, fitted
1	CEB2BB 2"Ball bearing flange block (Tail end)
1	CES3-2 2"Tail Shaft
1	CDS4-2 2"Drive Shaft (C1045 Mild Steel)

Cont'd.....

4	5/8"x3-5/8"lg Bolts with nuts
1	Lot of Std Sullivan Strong Scott shop coat (spray applied) primer paint, exterior surfaces only
1	Shop fabricated mild steel drive mounting base
1	Model MAAUD Size #287 David Brown Reducer Unit, Mtd @ discharge end, in position Top, Rated for Class II Service @ 18 Output RPM, c/w flange mounted 1 HP, 3/60/ 575 1800RPM, Class II Group G Explosion Proof Motor, Frame #56C
1	Chain Drive 18RPM-6RPM
1	Chain Drive Guard, Open Type, Mild Steel

Above conveyor assembled, fitted, match-marked and test run

BUDGET PRICE: $ 2,388.00

NOTE:

- STANDARD VARIABLE SPEED CONTROL $400 EXTRA (2.5:1 RATIO)
"AERODRIVE" " " " $ 1500 EXTRA (VARIABLE DOWN TO ZERO)
OR EQUIV.

FOR ALL SCREW CONVEYORS.

Cont'd.....

UNIT #2 - LIMESTONE FEEDER

?

ONE	4"dia. Screw Feeder Assembly 10'0"lg, inclined 0 to handle 1.6 CFH of Limestone weighing 85lbs./cu.ft., consisting of:
1	9'10"lgth 4S412 4"dia. RH Sectional Conveyor Screw, 3/16"thk flights half pitch for 8'6", full pitch for 1'0"with 4" of bare pipe on discharge end, standard intermittently welded to a 2-1/2"dia. Sch.40 pipe
1	2'0"lgth CHP407 4"dia. Formed solid tubular trough, mat'l 3/16"thk
2	Trough adaptor flange collars to join trough and customers bin
3	4"End flange gaskets, std black neoprene
1	Set flange gaskets, fitted, std black neoprene
1	lot of assembly nuts and bolts
1	CSD410F 4"flush end type Stub Discharge Spout less Slide, flanged & drilled, welded to trough
2	CEFT42 4"Tubular Trough End Plates for 2"dia.Shaft
1	CEB2RB 2"Roller bearing flange block (drive end)
2	CSW2 2"Waste pack seals, fitted
1	CEB2BB 2"Ball bearing flange block (tail end)
1	CES3-2 2"Tail Shaft
1	CDS4-2 2"Drive Shaft (C1045 M.S.)
4	5/8"x3-5/8"lg Bolts with nuts
1	Lot of Std S.S.S. Shop Coat (spray applied) primer paint, exterior surfaces only
1	Shop fabricated mild steel drive mounting base
1	Model MAAUD Size 287 David Brown Reducer Unit, Mtd @ Discharge end, in position Top, Rated for Class II Service @ 12 Output RPM, c/w flange mounted 1HP 3/60/575 1800RPM Class II Gr.G Explosion proof motor, frame 56C
1	Chain Drive 12RPM-3RPM
1	Chain Drive Guard, Open type, Mild Steel

Above conveyor assembled, fitted, match-marked and test run

BUDGET PRICE: $ 2,341.00

Cont'd.....

UNIT #3 - ASH FEEDER — NOT USED

ONE	4"dia. Screw Feeder Assembly 10'0"lg, inclined 0 to handle 3.8 CFH of Ash weighing 35lbs./cu.ft., consisting of:
1	9'10"lgth 4S412 4"dia. RH Sectional Conveyor Screw, 3/16"thk flights half pitch for 8'6", full pitch for 1'0" with 4" of bare pipe on discharge end, standard intermittently welded to a 2-1/2"dia. Sch.40 pipe
1	2'0"lgth CHP407 4"dia. formed solid tubular trough, mat'l 3/16"thk
2	Trough adaptor flange collars to join trough and customers bin
3	4"end flange gaskets, std black neoprene
1	Set flange gaskets, fitted, std black neoprene
1	Lot of assembly nuts and bolts
1	CSD410F 4"Flush end type Stub Discharge Spout less Slide, flanged & drilled, welded to trough
2	CEFT42 4"tubular trough end plates for 2"dia.. Shaft
1	CEB2RB 2"roller bearing flange block (drive end)
2	CSW2 2"Waste pack seals, fitted
1	CEB2BB 2"ball bearing flange block (tail end)
1	CES3-2 2"Tail Shaft
1	CDS4-2 2"Drive Shaft (C1045 Mild Steel)
4	5/8"x3-5/8"lg Bolts with nuts
1	Lot Std S.S.S. Shop Coat (spray applied) primer paint, exterior surfaces only
1	Shop fabricated mild steel drive mounting base
1	Model MAAUD Size 287 David Brown Reducer Unit, Mtd @ Discharge end, in position Top, Rated for Class II Service @ 18 Output RPM, c/w flange mounted 1HP 3/60/575 1800RPM Class II Gr.G Explosion proof motor, frame 56C
1	Chain Drive 18RPM-7.2RPM
1	Chain Drive Guard, Open type, Mild Steel

BUDGET PRICE: $ 2,341.00

Cont'd......

UNIT #4 - COLLECTOR CONVEYOR

ONE	6"dia. Screw Conveyor Assembly 10'0"lg, inclined 0 to handle 1000lbs./hr of Coal, weighing 50lbs./cu.ft., consisting of:
1	9'10"lgth 6H412 6"dia. RH Helicoid Screw Conveyor
1	10'0"lgth CTF610 6"formed flange trough
1	10'0"lgth CTC616 6"flanged cover
2	6"end flange gaskets
1	Set cover gaskets, fitted
3	CCAF6 6"Clampseals
3	5"x5"Inlet Spout, fitted
1	CH62262 2"Hanger Frame Style 226 for 2"bearings
1	CBX2H 2"dia. Hard Iron Hanger Bearing Inserts
1	CEF6-2 6"Trough end plate for 2"dia. Shaft
1	CEB2BB 2"Ball bearing flange block
1	CSW2 2"Waste pack seal, fitted
1	CEH2 2"Hardened Cplg Shaft
4	5/8"x3-5/8"Bolts with nuts
1	TEF6 Dorris Trough End
1	115W Dorris Motor Base
1	Model 115SCD20 Dorris Screw Driver Reducer Unit, Mtd @ Inlet end, in position Top, Rated for Class II Service @ 35 RPM
ONE	1-1/2HP V-Belt Drive, 1740-700 RPM, consisting of:
1	4.4"PD 2Gr "B" Section Sheave
1	SH Bushing 7/8"bore
1	11.0"PD 2Gr "B" Section Sheave
1	SK Bushing 1-1/4"bore
2	B-51 Matched V-belts (13.8"C-C)
1	V-Belt Drive Guard
1	1-1/2HP TEFC Motor, 3/60/550, 1800RPM, Fr.#145T

Above conveyor assembled, fitted, match-marked and test run

BUDGET PRICE: $ 2,700.00

Cont'd.....

ONE Model SCLC-2 Centrifugal Chain & Bucket Elevator having a discharge height of 10.5M handling 760CFH of Coal at 50lbs./cu.ft., and consisting of the following features:

- 8"x5"x5-1/2"x10ga. Style AA Buckets
- 16"Bucket Spacing
- 230ft./min Chain Speed
- 43 Headshaft RPM
- 14"x39"x10ga. Casing Size
- 3/16"thk Head Section with Discharge Spout and bolted inspection door
- 3/16"thk Boot Section with flanged Inlet, screw take-up, bolted inspection door
- SBS102B Chain
- 2-3/16" Head Shaft
- 1-7/16" Boot Shaft
- Model 115SM25 Dorris Reducer and Motor Mount
- 2HP Motor and V-Belt Drive

BUDGET PRICE: $ 13,700.00

F.O.B.: Downsview, Ont.
All Sales Taxes Extra, if applicable
Delivery: Screw Feeders 6 Weeks
Bucket Elevator 10-12 Weeks
Above deliveries are from receipt of approval drawings.
2-3 Weeks required for submittal of drawings

432 LIMESTONE HANDLING

A vacuum blower (Fan #4) shall be furnished, sized to deliver 0.8 kg/s of limestone and driven by a 15HP TEFC electric motor, to provide a vacuum for limestone transportation.

Limestone, delivered in drums to the front of the rig, enters the system through a flexible wand inserted into the drum and is conveyed to a separator on top of the limestone bin.

The separator shall be fitted with a dump valve discharging to the limestone bin.

This bin, sized for 900 kg limestone, shall be of conical cross section, fabricated in carbon steel with angle stiffeners and shall be furnished with a clamped cover.

Limestone shall be discharged by gravity to the variable speed limestone screw feeder.

Both the limestone bin and screw feeder shall be mounted on load cells similar to those fitted to the coal bin/feeder.

The limestone feeder shall discharge the limestone onto the transfer conveyor.

DATA SHEET

LIMESTONE FILLING

Material - Limestone

Size - -6 mm

Bulk Density - 1440 kg/m^3

Flowrate - 0.75-1.0 kg/s

Purpose - To prefill limestone bin prior to combustion test of rig.

Source - Drum

Height - 10 m

Hose Length - 15 m (est.)

Motor H.P. - *

Line Sizes - * inches

Receiver Dimensions (DIA/Height) - * ft.

Please complete items marked*

Control and Metering Limited
711 KIPLING AVENUE, TORONTO, ONTARIO M8Z 5G4,
TELEPHONE: (416) 259-8411 or TELEX: 06-967647

Transvac TR 300

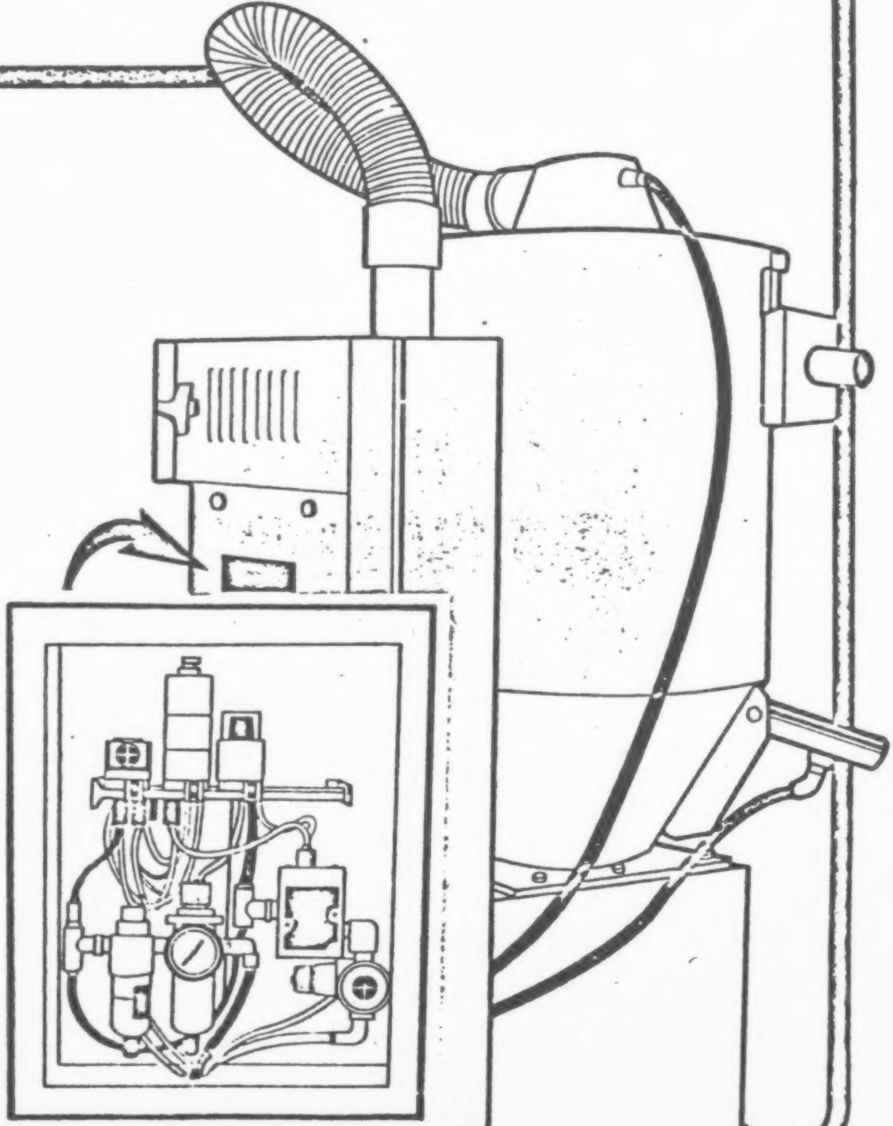
An automatic material handling system using vacuum to convey dry materials to or from process machinery or storage vessels.

FEATURES:

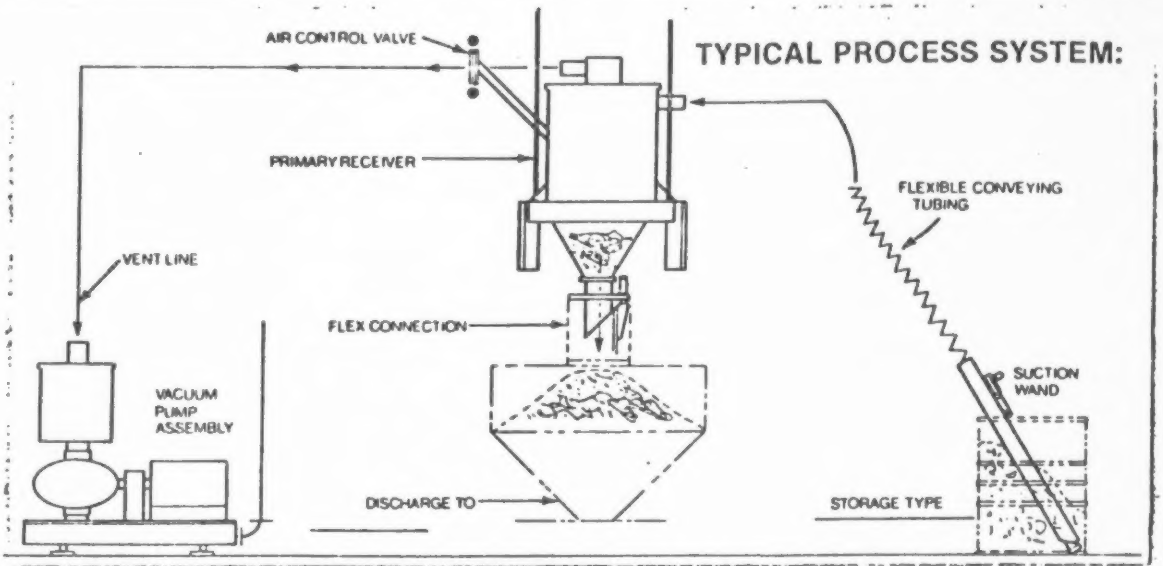
- Dust control.
- No pressure.
- Compact design.
- Few moving parts.
- Transfer rates to 20,000 lbs./hr. - higher rates depending on material.
- Conveying distances to 300 ft. - greater distance depending on material.
- Quiet 78 db
- Easy maintenance.
- Energy efficient and economical.
- Air logic control.
- Customized designs available to suit application.

OPERATION:

Operation is two cycle, automatic and continuous. Material moves into the hopper in the filling cycle. From a preset time controller, fill cycle stops and material falls out through a dump gate in the dump cycle.



TYPICAL PROCESS SYSTEM:



These cycles are automatically repetitive and stop only when the system is shut down or if scale or level-switch equipment is in command of the system.

During the FILLING CYCLE, these functions are basic and normal . . . Dump gate is closed, air control valve is open . . . Filter purge valve is closed, and vibrators at pick-up station are running. (Storage Vessel)

During the DUMP CYCLE, the filling cycle functions are either stopped or reversed and these functions occur . . . . . Wand purge valve opens allowing material entrained in the pipeline to continue on to receiver, and after an appropriate time delay, the following dump cycle functions occur simultaneously, dump gate open, discharge vibrator runs, filter is cleaned and air control valve is closed, allowing the hopper to vent and the vacuum pump to run on free air.

The basic cycle switching device consists of air logic timers set to suitable dwell times. However, depending on application, level switches in the receiving silo or process hopper, or a high level switch in the primary receiver, or other control equipment, will over-ride the basic timer system to control the flow of material.

Air logic controls are standard for safety considerations, but electrical controls are optional.

Each system can be adapted to suit a customer application and accuracy requirements for transfer rate.

OPTIONAL EQUIPMENT:

- Load cell for volume / accuracy and measurement.
- Digital readout and totalization.
- Vibrating bag-table or tilt-table.
- Vibrating feed bin.
- Live bottom feed bin.

If your material handling processes require dust control, accurate and economical transfer of dry materials from one process to another, then consider the benifits of vacuum conveying using the **TRANSVAC** TR 300

Designed and manufactured in
TORONTO, ONTARIO
by

Control and Metering
Materials Test Facility
Woodstock, Ontario

For a complete report on the ability of your material to transfer by vacuum.

Control and Metering Limited

C&M

711 KIPLING AVENUE, TORONTO, ONTARIO M8Z 5G4
TELEPHONE: (416) 259-8411 or TELEX: 06-967647

Transvac TR300

PRINTED IN CANADA

DATA SHEET

LIMESTONE FEEDER

Material - Limestone

No. of top inlet connections - One

No. of bottom outlet connections - One

Motor Drive - TEFC, 600 V/3 phase/ 60 Hz

Type of Screw - Taper Helicoid

Transmission - V-belt, infinitely variable manually adjusted speed control

Trough - Steel, flanged

Cover - Steel, flanged

Length - 3 m

Flowrate - 0.016 kg/s

Material Properties - -6 mm

4.4 BED DRAIN COOLER

Bed drain cooling and removal shall be by means of a variable speed, cooled feeder. The feeder shall consist of a jacketed trough and hollow feeder mechanism, both of which shall be of water cooled construction, fabricated in carbon steel and including a paddle type feeder, outboard bearings and external drive mechanism. The unit shall be completely shop assembled.

The feeder shall be suspended on structural members from the test rig lower floor. The final position shall permit access below the feeder for ash collecting drums as well as clearance above to allow removal of the combustor distribution grid and plenum.

Operation of the feeder shall be either continuous with manually adjusted speed control or intermittent with manually initiated start/stop.

DATA SHEET

BED DRAIN COOLER

Material - Bed residue (combination of limestone & ash)

Bulk Density - 1440 kg/m^3

Temperature - 871°C

Flowrate - 0.045 kg/s max. normal
0.002 kg/s min. normal

Particle size - -6 mm, plus occasional lump upto 50 mm dia.

Speed control - Variable speed drive

Cooling medium - Municipal water

Supply temperature - 26.7°C

Max. outlet temperature - 65°C

Supply pressure - 207 kPa

Required bed residue outlet temperature - 149°C

Speed range - * RPM

Required water flowrate - * USGPM

Motor horsepower - * H.P.

DATA SHEET

BED DRAIN COOLER (Cont'd)

Electrical power required - *V

Unit dimensions - *

Screw diagram - * Inches

Please complete items marked *

MECo. 12-027-1(9-79)

MONTREAL ENGINEERING COMPANY, LIMITED

RECORD OF TELEPHONE CONVERSATION

Date: 5 August 1982 Time: 3:00 p.m.

File No.: DSS 7914-9

Subject: Canmet Study Bed Drain Cooler

Between: Dick West, Mechanical Department of Montreal Engineering Co. Ltd.

And:

of: Control & Metering

(Bethlehem Corp. Sales)

The following budget price was given for Porcupine Model 12P1203 - $40,500 Can. d/d site.

Confirmation to follow: X (Yes) ____ (No)

Signature:

RPW/sc

Distribution

9th	Mr. R. Maclennan
8th	Mr. T. Wilson

Sheet ___ of ___

INSTALLATION COSTS:

Drive, bearings, process vessel and all auxiliary equipment are integrally mounted on a SINGLE BASE. *This UNITIZED CONSTRUCTION simplifies installation and minimizes installation costs.* In most cases, installation is accomplished by merely setting the unit on its foundation and leveling it.

MAINTENANCE:

Abrasion . . . corrosion . . . bearing life . . . packing . . . drives . . . These are only some of the variables that determine maintenance costs. The heavy-wall construction and low agitator speed make the PORCUPINE ideally suited to abrasive applications. HARD SURFACING of the agitator blades may be provided for severe applications. RE-TIPPING of worn blades is easily accomplished in the field. ROLLER BEARINGS, properly sized and designed for flush-through operation, are standard design. DRIVES are selected with your operating conditions in mind. SEALS are normally provided by using a stuffing box. For applications involving polymerizations, MECHANICAL SEALS have been provided.

By designing every PORCUPINE Processor System for each particular application — and employing carbon steel, stainless, nickel and nickel alloys — Bethlehem has engineered efficient systems for hundreds of successful heat-transfer applications! We would like to custom-engineer a PORCUPINE Processor for your heat-transfer requirements.

Pilot first ☐ Then decide with confidence

BEFORE you purchase any heat-transfer equipment, you should utilize Bethlehem's test laboratories . . . or rent pilot equipment from Bethlehem to check any process idiosyncracies. Bethlehem's engineers will work with you to develop the most efficient heat-processing system, tailored exactly to your process requirements.

Try us with a 55-gallon sample. (You will be pleased [illegible] the results.)

BATCH & CONTINUOUS RUNS:

Bethlehem's pilot equipment is designed for batch and continuous test runs; and our engineers will convert batch data to evaluate continuous operation. Heating capabilities run from 80° to 600°F (27° to 315°C). Coolant temperatures to below zero °F are available. Process equipment can be operated under vacuum or at pressures to 150 psig. Vacuum levels may be as low as 10 to 20 mm of Hg.

CONFIDENTIAL EVALUATIONS:

If you wish, Bethlehem engineers will conduct a complete investigation of your processing problems — on a confidential basis. Our comprehensive report, based on in-depth evaluations, will include specific proposals to help you decide on the best equipment or total system.

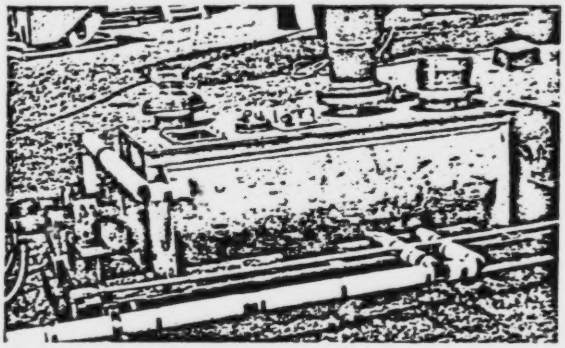


Fig. 9 Field Installation of Pilot Unit

PORCUPINE PROCESSORS: Available for On-Site Rentals or Laboratory Evaluations

Description	1P1203 JT	1P1203 JC	1P1206 JT	1P1206 JC	2Q1206 JT
Porcupine Diameter	12"	12"	12"	12"	12"
Effective Shaft Length	3'	3'	6'	6'	6'
Number of Shafts	1	1	1	1	2
Porcupine Surface, Sq. Ft.	15.0	12.2	30.0	24.4	60.0
Jacket Surface, Sq. Ft.	9.4	9.0	18.9	11.8	28.3
Shell Configuration	Trough	Cylindrical	Trough	Cylindrical	Recycle Trough
Materials of Construction	316 SS	316 SS	316 SS	316 SS	316 SS Shell 316 SS Agitators
Vessel Operating Pressure	Full Vacuum to 50 psig	Full Vacuum to 150 psig	Full Vacuum to 15 psig	Full Vacuum to 150 psig	Atmospheric
Porcupine Operating Pressure	150 psig	150 psig	150 psig	150 psig	150 psig
Jacket Operating Pressure	150 psig	150 psig	150 psig	150 psig	45 psig
D[illegible] Variable Speed, Explosion-Proof	1 Hp	1 Hp	2 Hp	2 Hp	3 Hp
C[illegible]ing Volume, Cu. Ft.	2.10	1.5	4.2	3.0	8.4
Mode of Operation	Batch or Continuous	Batch or Continuous	Continuous	Continuous	Batch, Continuous, Recycle
Agitators Available	T-Bar, Cup, Ribbon Porcupine	T-Bar, Cup, Ribbon Porcupine	Porcupine	T-Bar Porcupine	Porcupine Paddle
Weight, Shipping	2000 lb	2000 lb	3400 lb	3400 lb	4900 lb

4.5 FLUE GAS COOLER

The flue gas cooler shall consist of horizontal carbon steel tubes mounted in carbon steel downpass duct sections. The tubes shall be mounted in staggered rows and individually connected by couplings to 180° return bends, with the cooling fluid flowing upwards through the tubes from inlet to outlet headers. The duct sections shall be insulated with refractory or block insulation.

In order to achieve flexibility in operation, a large variation in surface area may be obtained by removing the entire lower section of the cooler. A replacement duct section shall be supplied and the cooling fluid circuit completed by hoses or pipe spools. Provision shall also be included for the removal and replacement of individual tubes with minimum disturbance to the section.

DATA SHEET

FLUE GAS COOLER

Type of cooler -	Flue Gas/Water Glycol
Tube side fluid -	Water-Glycol (60/40)
Internal pressure -	860 kPa
Design pressure -	860 kPa
Flowrate (max.) -	2.2 l/s
Gas Sides:	
Flow rate -	0.38 kg/s
Temperature (inlet):	871°C
Outlet temperature required -	171°C
Entrained material -	Upto 0.025 kg/s flyash
Construction:	
Approximate dimensions -	2m wide x 1m deep x 2m high
Effective tube length -	Approx. 1.4m
Tube diameter -	50mm

DATA SHEET

FLUE GAS COOLER (Cont'd)

Tube material -	Carbon Steel
Approximate no. of tubes -	109 (Three banks)
Approximate area -	$12m^2$
Heat load -	293 KWt

TRECAN
The Canadian Combustion Company

TRECAN LIMITED
4540 DIXIE ROAD
MISSISSAUGA
ONTARIO
L4W 1N2
(416) 625-4030
TELEX: 06-961261

June 17, 1982

Montreal Engineering Company Limited
P.O. Box 1540
St. Catharines, Ontario
L2R 7J9

ATTENTION: Mr. R. P. West

Re: Your File DSS-7914-9

Gentlemen:

We are responding to your letter of June 4, 1982 regarding a (i) Flue Gas Cooler and (ii) an ignitor for the proposed fluid bed combustion syste you are studying. Our comments are to provide a conceptual design description and budget cost and these can be followed up with specific quotations at the proper time.

(i) Flue Gas Cooler

The arrangement we have decided to recommend for the air cooled option is shown on the sketch attached dated 82/06/17. We prefe to use a style with the flue gas inside the tubes to make tube cleaning easier than the reverse. We had to go to 2 passes on the flue gas to keep the height such that it would match the flui bed height. This means the cooled flue gas outlet is near the tc but the duct to the baghouse inlet can be carbon steel.

To do the job within the 5 meter height available and with a single pass would involve the use of tubes under 1" dia., and we believe this may cause problems due to the dust.

The order of magnitude of cost for this cooler would be about $ 32-35,000, including the air fan.

If water were used, the cost would be 20-30% lower and the unit could easily fit into the 5 meter space.

......./2

(ii) Ignitor

~~This requirement is for a special version of one of our standard high heat release burners as shown in the HV burner sheet enclosed. The size would be a model 320. Special flanges would be used to allow for the back pressure. The valve train and other controls would be quite standard and your air supply pressure of 52" W.C. is adequate. We have supplied several of these fluid bed "ignitors".~~

~~The cost for the package including a local control cabinet would be about $ 12,000.~~

We hope the above comments are sufficient for your current needs. Call us if we can elaborate.

Yours very truly,

TRECAN LIMITED

WK Lombard

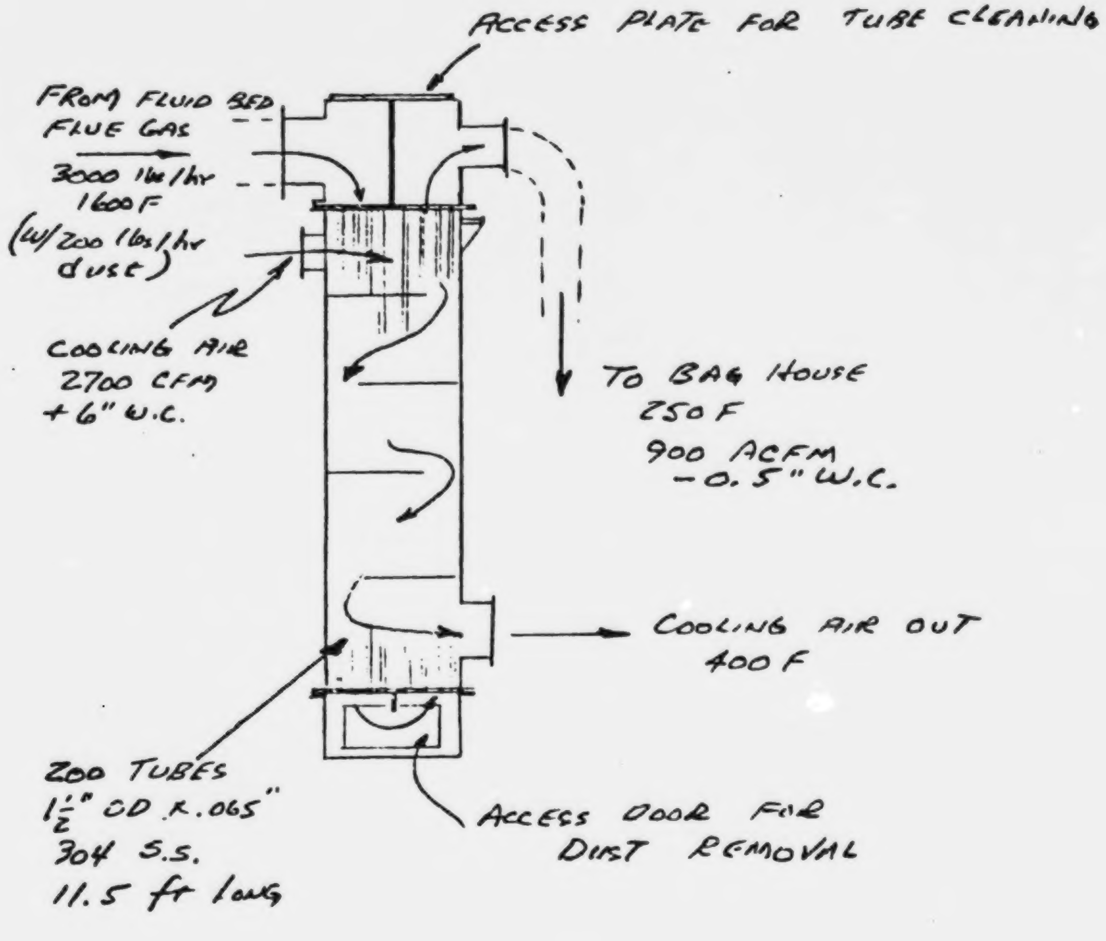
W. K. Lombard, P. Eng.
President

WKL/lc

Encl's

BY .... DATE 82/6/17 SUBJECT FLUE GAS COOLER SHEET NO. .... OF ....
CHKD. BY .... DATE .... MONTREAL ENG'G JOB NO. ....
FOR DSS

This design not adopted. Is example of air cooled Flue Gas Cooler.


ACCESS PLATE FOR TUBE CLEANING
FROM FLUID BED FLUE GAS
3000 lbs/hr
1600 F
(w/200 lbs/hr dust)
COOLING AIR
2700 CFM
+6" W.C.
TO BAG HOUSE
250 F
900 ACFM
-0.5" W.C.
COOLING AIR OUT
400 F
200 TUBES
1½" OD x .065"
304 S.S.
11.5 ft long
ACCESS DOOR FOR DUST REMOVAL

OVERALL HEIGHT ± 16'
3' x 3' CROSS-SECTION
6000 lbs TOTAL WT.

4.6 ASH COLLECTOR/RECYCLING/REMOVAL

The dust collector shall be of the bag filter type furnished with an automatic air-pulse system for bag cleaning. A manually operated bypass duct shall also be provided.

Twin hoppers shall be furnished, constructed in carbon steel with 70° minimum sloping sides to prevent hang-up of ash. The hopper capacity shall permit an 8 hour test run on the worst fuel without requiring ash removal.

The collector shall be furnished with motorised rotary outlet valves, supporting structure and insulation. Normal discharge shall be via a flexible hose connected to the discharge valve. For the purposes of recycling ash back to the combustor, one or both outlets shall be connected to an eductor which shall be supplied by transport air bled from the F.D. fan discharge. The required ash flow rate shall be achieved by manually adjusting the rotary valves.

DATA SHEET

DUST COLLECTOR

Type of collector - Bag filter

Construction - Carbon steel

Hopper required - Yes, min. 70° slopes

Medium - Flue gas

Temperature - 171°C

Mass flow - 0.378 kg/s.

Dust load - 0.1 kg/m^3

Pressure - -500 mm W.G.

Dust sizes - 90% < 20mm

Bag cleaning - Automatic Air Pulse

MECo. 12-027-1(9-79)

MONTREAL ENGINEERING COMPANY, LIMITED

RECORD OF TELEPHONE CONVERSATION

Date: 10 June 1982 and 10 August 1982 Time:

File No.: DSS 7914-9

Subject: Dust Filters for Canmet Pilot Plant Study

Between: T. Wilson of Montreal Engineering Co. Ltd.

And: J. Marchant

of: McCarthy & Robinson Ltd.

J. Marchant quotes the following prices for SLY dust filters which McCarthy & Robinson Ltd. market in Canada:

SLY PACTECON Pulse Cleaned Filters.

Model PC 104 (1,000 ACFM) high temperature unit CAN. $19,554

Model PC 106 (1,400 ACFM) high temperature unit CAN. $25,126.

(standard unit CAN. $13,906.)

J. Marchant recommends the larger unit i.e. PC 106 for this study primarily because of the high dust loading, the PC 106 has a 2·7:1 air to cloth ratio. The high temperature units come complete with 'Nomex' bags, good for 425°, high temperature gaskets and seals, cast iron discharge valves, epoxy paint and standard supports.

Confirmation to follow: X (Yes) ______ (No)

Signature: ______

TW/sc

Distribution

10th	T. Green
9th	R. MacLennan
9th	R. West

Sheet 1 of 1

MECo. 12-027-1(9-79)

MONTREAL ENGINEERING COMPANY, LIMITED

RECORD OF TELEPHONE CONVERSATION

Date: 10 August 1982 Time: 3:00 pm

File No.: DSS 7914-9

Subject: Canmet Pilot Plant Study: Dust Filters

Between: T. Wilson of Montreal Engineering Co. Ltd.

And: Howard Bushnell

of: McCarthy Robinson Ltd.

This is an update on the information received from J. Marchant of McCarthy Robinson, Telephone record 10 August 82.

The PC104 unit quoted has 2 hoppers because of the dust loading (normally this size only has one hopper).

Prices quoted include:

- 2-8" cast iron motorized (including gear reducer) rotary valves per unit.
- Nomax high temperature bags.
- air shut-off valves with silicone rubber components.
- Casing gaskets - silicone rubber.
- Timer has special stand-off mounting with insulation.
- Units are finished with epoxy paint both inside and outside.
- The units are uninsulated.

Confirmation to follow: _____ (Yes) _____ (No)

Signature: ________________

Distribution

	Mr. T. Green
	Mr. R. MacLennan
	Mr. R. West

Sheet 1 of 2

MECo. 12-027-1(9-79)

MONTREAL ENGINEERING COMPANY, LIMITED

RECORD OF TELEPHONE CONVERSATION

Date: 10 August 1982 Time: 3:00 pm

File No.: DSS 7914-9

Subject: Canmet Pilot Plant Study: Dust Filters

Between: T. Wilson of Montreal Engineering Co. Ltd.

And: Howard Bushnell

of: McCarthy Robinson Ltd.

- Because of the special features, the units are not constructed on the assembly lines but constructed as special one-off units. This adds considerably to the cost of the units.

The quoted prices included freight, however, there was an error introduced by including the agents fee twice. Therefore, the real price of the units is approx 10% less than the quoted price.

As a general statement the price differential between high temperature units and standard units is as follows:

PC 104 unit	high temp unit ≈	standard unit x 2.55
PC 106 unit	high temp unit ≈	standard unit x 2.34

TW/jj

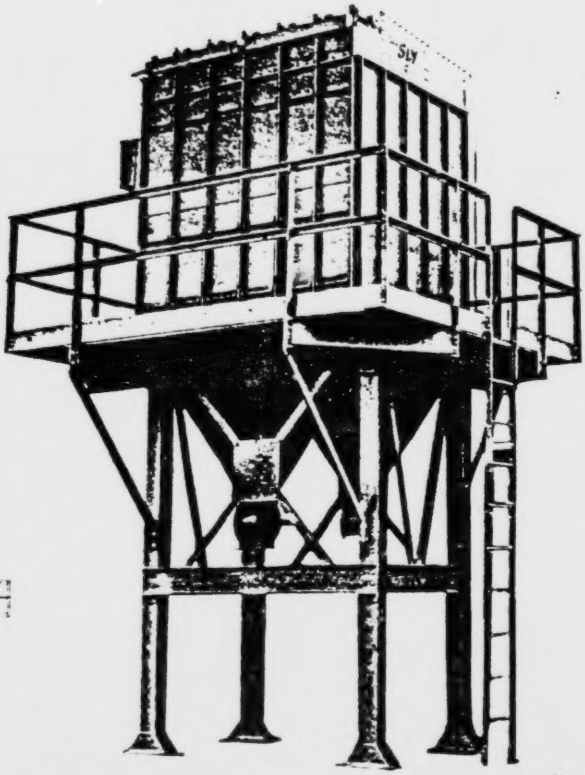
Confirmation to follow: ______ (Yes) ______ (No)

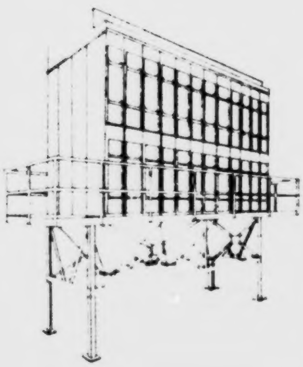
Signature: T. Wilson

Distribution

Sheet 2 of 2

SLY
SINCE 1874

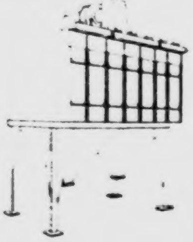




PACTECON®

Model PC

Pulse-cleaned Filters to 25,000 CFM



- Safe
- Efficient
- Compact
- Economical
- Quick Delivery
- Delivered Assembled

SINCE 1874 SLY

PACTECON®

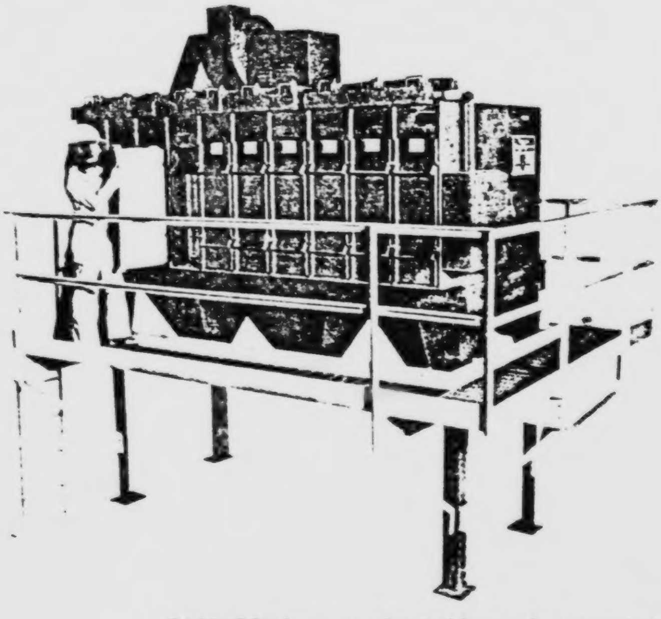
From more than 100 years experience... *a better dust filter concept*

PACTECON is compact and completely self-contained. It's built entirely of in-stock parts making it less expensive to build, more economical to buy, faster to deliver and easier to install.
It's uncomplicated, yet rugged; efficient, yet economical to operate.
Heavy duty units are available for all types of air pollution control. They handle 980 to 25,575 CFM and temperatures to 250°F. Flat envelope-type bags make it possible to fit a maximum amount of cloth into a minimum amount of space. So PACTECON dust filters have more cloth per cubic foot of filter than ordinary dust filters.

Continuous suction with automatic air-pulse cleaning

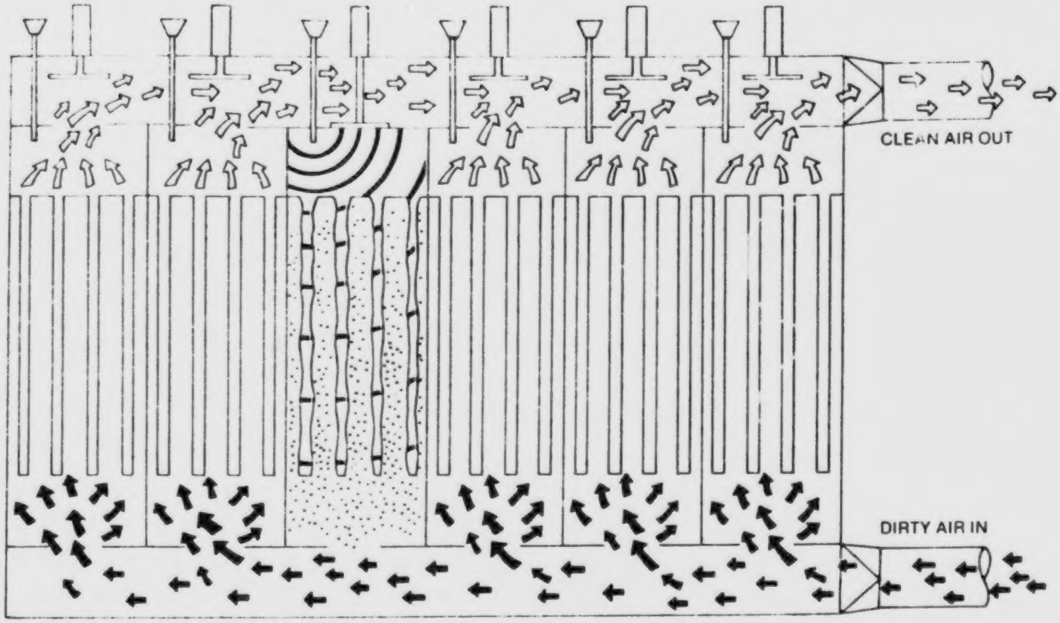
PACTECON Model PC is designed for applications where process shutdown for filter bag cleaning is either impossible or impractical. A simple, maintenance-free pulse clean system automatically keeps bags clean — continuously.
Our bag cleaning method is non-destructive. Cleaning pulses are uniformly distributed into each cell, causing envelope-type bags to flex. Excess dust is removed without damaging the fabric.
PACTECON units are 2 to 8 cells (modules) wide in the PC-100, with 4 bags per cell, and 5 to 24 cells (modules) wide in the PC-200, with 8 bags per cell. The envelope-type bags provide greater filter compactness. Higher cleaning efficiency and longer bag life are assured by use of heavy synthetic felts. Since individual cells are pulse-cleaned in a carefully controlled sequence, cleaning is thorough and non-destructive.
Pulse-clean air valves, solenoids, timers, piping and other components are installed on every filter prior to shipping. Filters are shipped with bags installed and are ready for mounting, hook-up and start-up.

Construction features



PACTECON bags are changed from safe, convenient walkways. No need to climb on top — or inside — the filter.

The PACTECON filter case is made of heavy gauge construction designed for pressure up to 20" W.G. and is protected by two coats of paint, the second one after final assembly. The case is mounted on a heavy structural channel frame, pre-punched for structural support or bin mounting. All inspections, adjustments and repairs are made either from outside the case or thru quick-release front and rear doors. **It is never necessary to enter the case.** Inlet openings with cover plates are provided on each side of the case. Either may be quickly removed by the customer and adapted to his inlet pipe.
The PC-100 provides for roof-top mounted fans. The PC-200 is equipped with end access panels for connection to separately mounted fans. Hoppers of 14 ga. steel are assembled and ready for installation. A variety of dust discharge valves are available from stock. Heavy, gusseted, structural supports are furnished, as standard, for heights up to 10 feet. Higher supports are available for special applications.

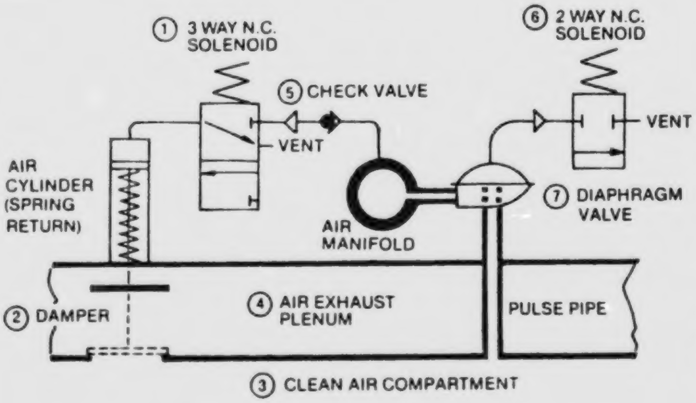


How PACTECON® Model PC Operates

The basic filter consists of a number of modules or sections, the number being determined by the gas volume to be handled. Each section contains four (PC-100) or eight (PC-200) envelope-type filter bags. The sections are cleaned individually, **off-line,** in a sequence controlled by a solid state timer.

The cleaning cycle operates continuously, beginning with the first cell. The timer energizes a 3-way solenoid (1), closing the damper (2), to isolate the cell (3), from the air exhaust chamber (4), stopping the air flow to the cell. A check valve (5), functions as a safety feature in the system to prevent an unprogrammed damper opening. After a 5-second dwell, a 2-way solenoid (6), is energized to vent the diaphragm valve (7), allowing it to open suddenly and send a shock wave of compressed air into the clean air compartment. The shock wave travels into the filter bags, breaks the dust cake and allows the dust to fall into the hopper below. Duration of the initial pulse is adjustable from 50 to 150 milliseconds. After a 5-second dwell, a second pulse is initiated (adjustable from 1 to 10 pulses per cell). A final 5-second dwell allows dislodged dust to settle to the hopper before the 3-way solenoid is de-energized, opening the damper and returning the cleaned cell to service. After an adjustable 2-12 minute pause, the next cell is removed from service for cleaning. The cleaning cycle is repeated continuously, returning to the first cell after the last cell has been cleaned.

Maximum air usage is 8.5 SCFM @ 90 PSI for the PC-100 Series; 17 SCFM for PC-205 thru PC-212 and 34 SCFM for PC-213 thru PC-224. **Actual air consumption** is typically about ¼ of these air rates.



Air pollution control advantages

EFFICIENCY: Guaranteed to be 99.9% collection of all dust over ½ micron size, from cement to carbon black.

LOW MAINTENANCE: A minimum number of moving parts means long, trouble-free service.

SAFE, EASY ACCESSIBILITY: All inspection, adjustments or repairs, including bag changes, are made

ADAPTABILITY: Conservative air-to-cloth ratios and high technology felt bags make PACTECON suitable for all dry dust applications.

LOW COST: PACTECON sells for less per CFM than other comparable dust filters. This is possible because PACTECON is made from standard off-the-shelf parts.

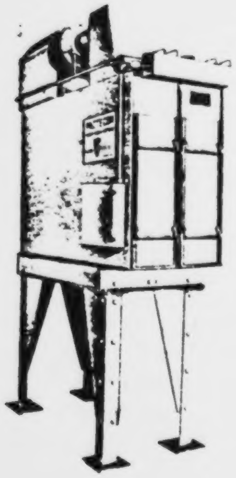
COMPACTNESS: Sly filters have always been the most compact in the industry. The PACTECON requires still less cubic feet of space per unit capacity than our already compact line.

SHOP ASSEMBLY: PACTECON filters leave our plant assembled, with bags installed. You only have to mount PACTECON on our supports or your base, and bolt on hoppers when required. Fans can be shipped installed when truck size permits. Your installation time and costs are reduced by ⅓.

FAST DELIVERY: Assembly of your PACTECON from

SINCE 1874
SLY

PACTECON® Model PC-100



PC Standard Equipment

Outside bag changing from support level.
Heavy 14 gauge metal case.
Heavy channel frame and structural support.
13" compartments, each isolated from its neighbor.
Bolted construction with closed cell neoprene gasketing.
60°, 14 gauge hoppers with hand-operated valves.
Gasketed, quick-release doors front and rear.
Two coats of paint, the second after final assembly.
16 oz. polyester felt bags with rubber covered spacers.
Low-loss plenums and dampers with inlets on either end.
Outlets on either end on PC-200 and on roof on PC-100.
Solenoids, cylinders and valves installed.
Interconnecting compressed air piping on unit.
Solid state timer in NEMA 12 enclosure (110 volt control).
Shop assembled, including bags.

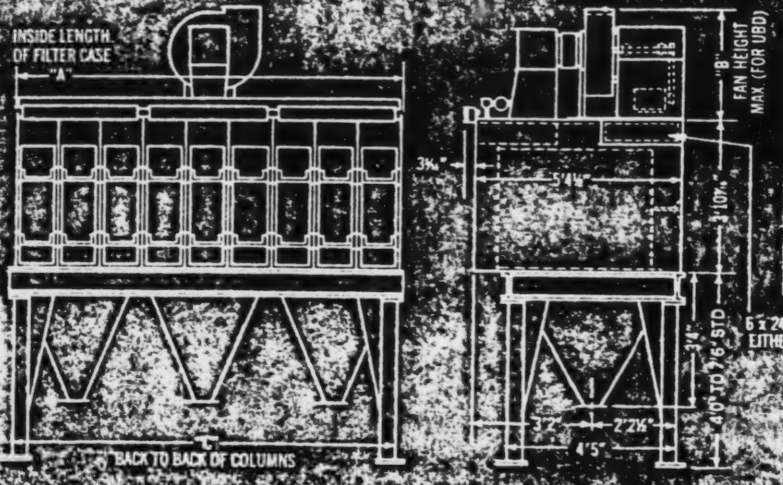
PC-100 Optional Equipment

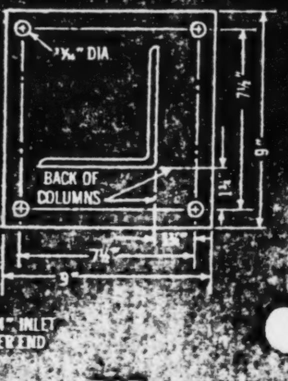
Fans, motors, V-belt drives in compact, integral units.
Fan pipes with blast gates.
Rotary valves, valve drives, hopper rappers.
Trough hoppers, screw conveyor.
Special structural supports.
Special filter fabrics.
Grounded filter bags.
Special motors and drives.
Special fans and/or mounting.
Walkways, rails, grating.
Prewired control panels.
Completely wired units.
Air compressors and accessories.

PC-100 SPECIFICATIONS

Model PC Size	Capacity (CFM) At: 5:1 Ratio	6:1 Ratio	No. of Bags	Cloth Area Sq. Ft.	No. of Hoppers	Length of Filter Case Dimension "A"	Fan Height Dimension "B"	Back-to-Back of Columns Dimension "C"	Fan Motor H.P.	Weight (Lbs.)
102	890	1068	8	178	1	2'-2¼"	30"	2'-3¼"	7½	1350
103	1330	1596	12	266		3'-3⅜"	30"	3'-4⅜"	7½	1610
104	1775	2130	16	355		4'-4½"	34"	4'-5½"	10	1840
105	2220	2664	20	444	2	5' 5⅝"	34"	5' 6⅝"	15	2240
106	2665	3198	24	533		6'-6¾"	46"	6'-7¾"	15	2510
107	3110	3732	28	622		7'-7⅞"	46"	7'-8⅞"	20	2820
108	3550	4260	32	710		8'-9"	46"	8'-10"	20	3350

RINCIPAL
IMENSIONS
C-100 SERIES


INSIDE LENGTH OF FILTER CASE "A"
"C" BACK TO BACK OF COLUMNS
3⅝"
5'4½"
3'10⅝"
"B" FAN HEIGHT MAX (FOR UBD)
6 x 24" INLET EITHER END
40" TO 76" STD
3'2"
2'2½"
4'5"



PAD DIMENSIONS

4.7 COOLING LOOP

The system shall consist of the following:

- Outdoor (roof mounted) evaporative air/water-glycol cooler
- Cooling Water-Glycol Pump
- Pressure Control Valve
- Temperature Control Valve
- Piping and Accessories

The hot cooling fluids discharged from the combustor bayonet tubes, flue gas cooler and bed drain cooler shall be collected into a common header. This header shall be connected to an air/water-glycol cooler mounted outside the laboratory on the roof (or at grade on support steel). The air/water-glycol cooling circuit shall consist of a once-through evaporative type cooler complete with water pump, sump, level control, drains, immersion heater for stand-by, centrifugal fan and air flow control louvres. The whole unit, once started, shall operate automatically to control the cooling fluid discharge temperature at the required level. Should this temperature fall below a pre-set minimum set point, a temperature control valve shall by-pass warm cooling fluid in order to maintain the return temperature to the test facility at the minimum set point.

The cooling fluid shall discharge from the air/water-glycol cooler to the suction of the cooling loop circulating pump via interconnecting piping. This pump shall boost the fluid pressure in order to overcome system resistance and circulate the cooling medium through the respective services.

A pressure switch and pressure indicator shall be furnished in the discharge of the circulating pump to provide system monitoring capability. When low pressure is detected by the pressure switch, an alarm shall sound to warn the operator to shut down the system in order to prevent steam generation in the cooling services.

A pressure safety valve shall also be included in the system to prevent damage from excessive pressure build-up due to excess temperature effects or mis-use. Monitoring of flows in the various parts of the system shall be connected to the alarm system to signal any loss of cooling fluid.

DATA SHEET

AIR/WATER-GLYCOL COOLER

Environment - Outdoor location

Type of cooler - Air/Water-Glycol

Tubeside fluid - Water-Glycol (60/40)

Number of passes - Once Through

Material of construction - Steel Casings - with corrosion resistant coating

Type of forced draft - Centrifugal Fans

Number of fan drivers - One

Type of drive - V-Belt

Maximum fluid inlet temperature - 66°C

Heat load - 733 kW

Required outlet temperature - 30°C

Design ambient temperature - 27°C

Air flow control louvres required - Yes

DATA SHEET

AIR/WATER-GLYCOL COOLER (Cont'd)

Evaporative type coolers -	Acceptable
If Evaporative cooler -	Sump heater required Drain point required

DATA SHEET

COOLING WATER - GLYCOL PUMP

Type of Pump -	Centrifugal
Mounting -	In-Line
Motor -	TEFC 600V/3 phase/60 Hz flange mounted
Connections -	Flanged FF, 125 lb.rating
Construction -	Nodular iron casing, cast iron impeller
Discharge Head -	350 kPa
Flow rate -	8 l/s
Inlet temperature -	30°C
Fluid -	Water-Glycol (60/40)
Seal -	Stuffing box
Suction -	Flooded
NPSH Available -	7.5 m

DATA SHEET

TEMPERATURE CONTROL VALVE

Fluid -	Water-Glycol (60/40)
Temperature -	66°C
Actuator -	Direct acting with capillary tube temperature sensor.
Set Point -	20°C
Body -	Steel
Trim -	Stainless Steel
Connections -	Flange RF, 150 lb. rating

DATA SHEET

COOLING WATER PUMP, PRESSURE CONTROL VALVE

Fluid - Water-Glycol (60/40)

Temperature - 35°C

Flow rate - 3.15 L/s

Pressure Set-Point - 517 kPa approx. (adj.)

Actuator - Direct Acting

Size of Line - 80 mm

Body - Steel

Trim - Stainless Steel

Connections - RF 150 lb. rating

QUOTATION

H. E. RIECKELMAN (CANADA) LTD.
2104 BROMSGROVE ROAD MISSISSAUGA ONTARIO L5J 1L4
TELEPHONE (416) 823-9440

August 4, 1982

SUBJECT: BAC COOLER FOR PROPOSED FUEL TESTING FACILITY FOR MINISTRY OF ENERGY, MINES, & RESOURCES, OTTAWA, ONTARIO

Montreal Engineering Company Ltd.,
1 St. Paul Street,
St. Catharines, Ontario L2R 7J9

Attention: Mr. Dick West

Dear Sir:

We wish to confirm our quotation for the Closed Circuit Industrial Fluid Cooler as manufactured by Baltimore Aircoil of Canada, in Georgetown, Ontario.

To cool 112 USGPM of glycol solution 40% by volume from 135 degrees F. to 85 degrees F. with 75 degrees F. entering air wet bulb.

One (1) Model VXI-105-2 .... Net $ 30,450.00

Included:

One (1) 30 HP., Std.V./3 Ph./60 Hz. fan motor with 1.15 service factor, for 0" E.S.P.
One (1) 5 HP., Std.V./3 Ph./60 Hz. spray water pump and pump motor.
Float, make-up valve and strainer.
Modulating freeze-proof capacity control dampers complete with electric damper controls.
One (1) 12.0 kw. electric pan heater complete with temperature controller and low water level cutout.
Temperature controller for spray pump.
H.D.G. steel construction with BALTIBOND^{TM} Corrosion Protection System on all steel parts except coil, solid fan shafts, and pump and pump piping.

Not Included:

Structural steel supports.
Coil circuit pump and pump motor.
Starters or disconnect switches, and wiring.
Rigging, hoisting or final assembly.
Contactor, control transformer and wiring of pan heater.

Approximate shipping weight:	15,100 lbs.
Approximate operating weight:	22,360 lbs.

Spray water circulation is 460 USGPM with 2.0 PSI. required at the spray header.
Pressure drop through coil .6 PSI.

continued ....

F.O.B. Georgetown, Ontario with freight prepaid and allowed to Ottawa, Ontario.

Unit is shipped in two sections, the heaviest section weighs 10,320 lbs. Allow 4 - 6 man hours for final field assembly.

Federal and Provincial Sales Taxes are extra.

Sincerely yours,

H. E. RIECKELMAN (CANADA) LTD.
Sales Representatives for
Baltimore Aircoil of Canada

S. D. Phin, P. Eng.

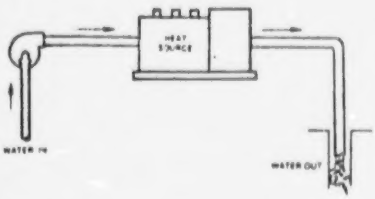
SDP:new

(See enclosure for Terms)

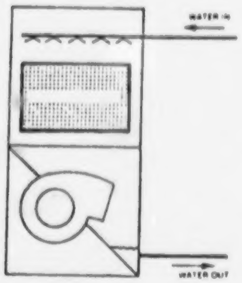
INDUSTRIAL FLUID COOLERS

closed circuit evaporative cooling

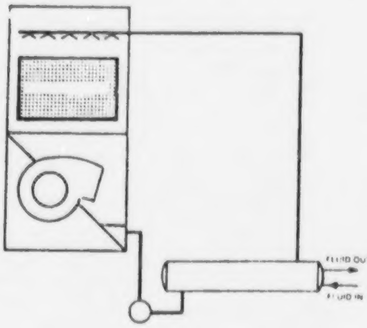
Save Energy...Save Water... Reduce Maintenance Compared to Other Systems:



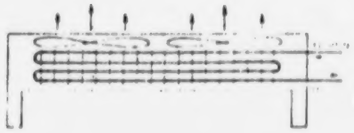
"ONCE THROUGH"
Water circulated once through a heat exchanger with a temperature rise of 20°F removes 20 btu per pound of water. Evaporation of each pound of water removes approximately 1,000 btu. With a bleed rate equal to the evaporation rate an Industrial Fluid Cooler saves about 95% of the water previously required for cooling. Often the initial investment in the Industrial Fluid Cooler can pay back in one year.



OPEN COOLING TOWER
This equipment saves water but allows the process water to directly contact the airstream and become contaminated with impurities which can cause corrosion or scaling of heat exchangers. Industrial Fluid Coolers reduce heat exchanger maintenance because the process water is circulated in a clean, closed loop.



COOLING TOWER WITH HEAT EXCHANGER
This combination saves water and provides closed loop cooling, but first cost is higher than an Industrial Fluid Cooler because two pieces of equipment must be installed and piped. Energy costs are also higher because the cooling tower requires a larger pump for the open water loop.



DRY AIR COOLER
This unit uses sensible cooling and requires higher airflow and larger coil surface than an Industrial Fluid Cooler employing the more efficient evaporative cooling. The Industrial Fluid Cooler is less expensive, uses less energy, and can produce colder fluid.

Typical Applications

Air Conditioning
Unitary heat pump systems
Central heat reclaim systems
Refrigeration supplement

Industrial Fluids
Hydraulic oils
Plating solutions
Quench oils

Steel Mill and Foundries
Blast furnace
BOF
Continuous casters
Induction furnaces
Quench tanks
Rolling mills

Manufacturing
Air compressors
Die casting machinery
Engines
Extrusion processes
Plastic molding machines
Plating equipment
Transformers
Welding machines
Wire drawing machinery

Power Generation & Transmission
Compressors
Engines and Generators
Thyristor banks
Turbine bearings

Chemical Process
Barometric condensers
Trim cooling

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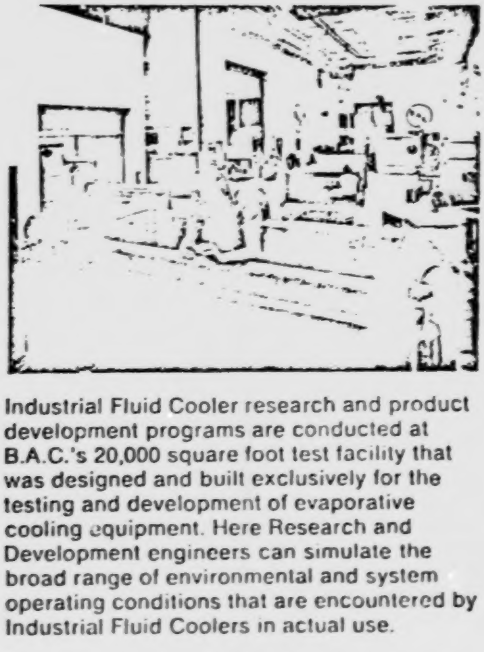
VX

Dependability through engineering leadership and experience

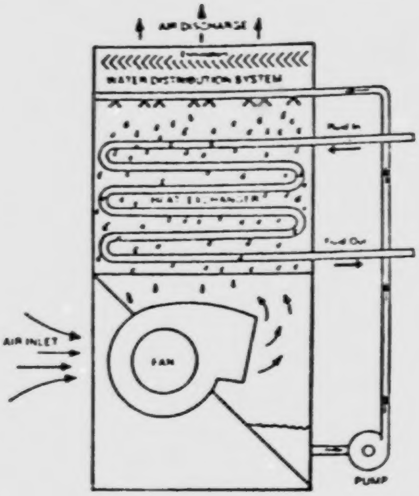
Since its founding in 1938, Baltimore Aircoil Company has specialized in the design and manufacture of evaporative cooling equipment, and has become a worldwide leader in this field. B.A.C.'s continuing program of engineering research has resulted in many Industrial Fluid Cooler design innovations, including the introduction of the V-Line Industrial Fluid Coolers in 1968 that have become the standard of the industry.



Industrial Fluid Cooler research and product development programs are conducted at B.A.C.'s 20,000 square foot test facility that was designed and built exclusively for the testing and development of evaporative cooling equipment. Here Research and Development engineers can simulate the broad range of environmental and system operating conditions that are encountered by Industrial Fluid Coolers in actual use.

The VX Industrial Fluid Cooler design is the latest result of B.A.C.'s commitment to product innovation through engineering research. While maintaining the basic features of the original V-Line, major improvements have been built into the VX design to meet the needs of today's air-conditioning, equipment cooling and industrial process cooling systems.

PRINCIPLE OF OPERATION



The fluid to be cooled is circulated inside the tubes of the unit's heat exchanger. Heat flows from the process fluid through the coil tubes to the water outside which is cascading downward over the tubes. Air is forced upward through the coil, evaporating a small percentage of the water, absorbing the latent heat of vaporization and discharging the heat to the atmosphere.

The remaining water falls to the sump to be recirculated by the pump while water entrained in the airstream is reclaimed and returned to the sump by mist eliminators at the unit discharge. The only water consumed is the amount evaporated plus a small amount which is intentionally bled off to limit the concentration of impurities in the pan.

Patents: This equipment is manufactured under one or more of the following U.S. Patents: [illegible], [illegible], [illegible], [illegible], 3575387, [illegible], [illegible]. This equipment is also manufactured under numerous foreign patents and pending United States and foreign applications.

© [illegible] Baltimore Aircoil Company, Inc.

Performance Data / VXI Centrifugal Fan VXMI Multi-Stage Axial Fan

To select unit, enter the Performance Factor column at or just below the selected Performance Factor. Read down the column to a flow rate equal to or greater than the design flow rate. Read the recommended unit size in the far left column.

If the selected Performance Factor is not an integer, interpolate the flow rate between Performance Factor columns to determine unit capacity at design conditions.

Notes:

1. Do not extrapolate gpm data beyond printed range.
2. The most economical unit selection will be in clear area. Alternative unit selections are provided in the shaded areas for special jobsite requirements such as space, pressure drop or height.
3. *Indicates this point should be used for interpolation only. Do not exceed maximum GPM.
4. When the coil pressure drop (page 16) is below 3.0 psi, special circuiting may be available to reduce unit size. Contact your Baltimore Aircoil representative.

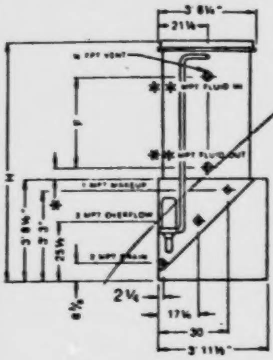
VXI and VXMI

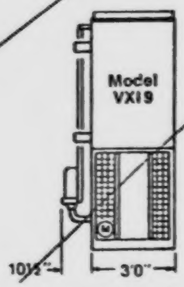
UNIT SIZE	MAX. GPM	PERFORMANCE FACTORS														
		2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	✓ 15.0	16.0
9-1	330	135	83	56	41	30	23	17	—	—	—	—	—	—	—	—
9-2	330	155	96	66	48	36	28	21	17	—	—	—	—	—	—	—
9-3	330	185	116	80	60	47	37	29	23	18	—	—	—	—	—	—
18-0	405	300	178	118	84	63	49	38	31	24	20	—	—	—	—	—
18-1	405	350	212	142	103	78	61	48	40	32	28	21	18	—	—	—
18-2	405	395	243	165	121	92	73	58	48	39	34	29	24	19	17	—
18-3	405	405	300	206	152	118	95	76	63	52	45	39	33	27	24	21
27-1	405	530*	330	221	159	120	93	72	58	46	39	33	27	22	18	—
27-2	405	600*	375	257	187	140	111	88	72	58	49	40	33	27	24	21
27-3	405	—	405	310	230	175	139	110	91	74	63	53	44	37	34	30
36-2	405	—	510*	370	274	205	165	128	106	85	72	59	49	40	35	31
36-3	405	—	—	405	330	260	210	165	137	113	97	80	68	57	51	46
50-1	585	—	660*	470	346	260	202	155	125	100	83	68	56	46	39	33
50-2	585	—	740*	530	400	305	240	190	156	125	105	88	72	60	52	44
50-3	585	—	—	579	431	335	265	210	173	140	117	98	82	68	60	53
70-1	810	—	810	579	420	310	238	181	144	115	97	79	64	52	43	35
70-2	810	—	1000*	725	540	418	326	255	208	168	140	117	96	80	70	60
70-3	810	—	—	840*	640	495	390	312	252	208	174	146	121	103	90	76
105-1	810	—	—	990*	745	580	450	360	290	240	200	170	133	108	89	75
105-2	810	—	—	—	810	660	530	428	350	290	241	205	175	142	123	106
105-3	810	—	—	—	900*	730	594	480	400	330	275	250	195	166	146	125
120-1	1290	—	1260	960	705	530	410	320	256	206	167	140	115	96	92	72
120-2	1290	—	—	1080	830	630	500	398	320	257	212	175	145	125	110	93
120-3	1290	—	1550*	1158	880	680	545	436	352	286	239	200	166	142	130	100
140-1	1620	—	1620	1158	840	620	475	361	288	230	187	155	125	105	86	71
140-2	1620	—	2000*	1450	1080	836	652	510	416	336	285	225	187	160	140	120
140-3	1620	—	—	1680*	1280	990	780	624	504	416	348	292	242	206	180	152
180-1	1290	—	—	1500*	1130	870	675	538	435	360	290	250	195	166	133	107
180-2	1290	—	—	—	1370*	1050	875	715	585	480	400	340	289	245	208	175
180-3	1290	—	—	—	1500*	1175	970	790	655	540	453	380	322	280	242	210
210-1	1620	—	—	1980*	1490	1160	900	720	580	480	400	340	266	216	188	150
210-2	1620	—	—	—	1620	1320	1060	856	700	580	482	410	350	284	246	212
210-3	1620	—	—	—	1800*	1460	1188	960	800	660	550	500	390	332	292	250
240-1	2580	—	2520	1920	1410	1050	820	636	510	408	333	275	225	190	160	132
240-2	2580	—	2950*	2160	1660	1260	1000	796	630	510	418	350	288	245	205	174
240-3	2580	—	3100*	2316	1760	1360	1090	872	704	572	478	400	332	284	260	215
360-1	2580	—	—	3000*	2260	1740	1350	1075	870	720	580	500	390	325	265	214
360-2	2580	—	—	—	2740*	2100	1750	1430	1166	960	800	680	578	490	416	350
360-3	2580	—	—	—	3000*	2350	1940	1580	1310	1080	906	760	644	560	484	420

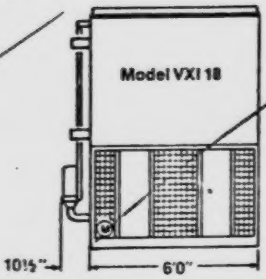
Engineering Data / Models VXI 9 t

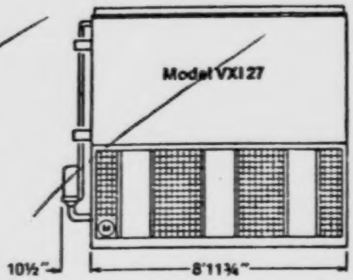
Do not use for construction. Refer to factory certified dimensions.
In the interest of product improvement, specifications and dimensions are subject to change without notice.

Model VXI 9 to VXI 36


3' 8⅛"
21⅛
MPT FLUID IN
MPT FLUID OUT
1 MPT MAKEUP
2 MPT OVERFLOW
2 MPT DRAIN
H
3' 8⅛"
3' 3"
25⅛
2⅛
6⅝
17⅛
30
3' 11⅛"

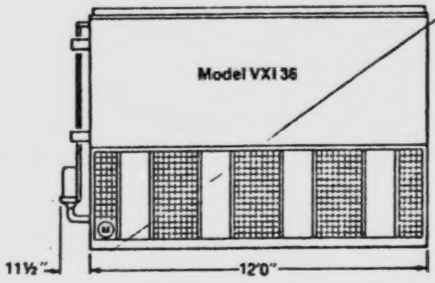

Model VXI 9
M
10½"
3'0"


Model VXI 18
M
10½"
6'0"

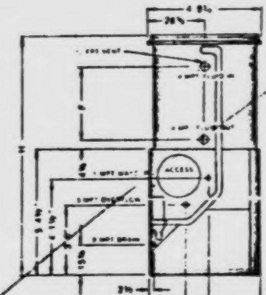

Model VXI 27
M
10½"
8'11¾"

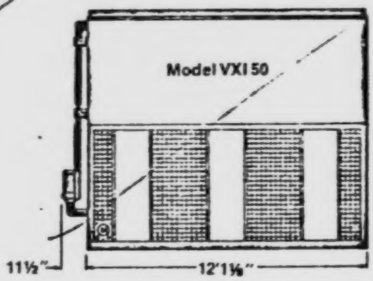
Ⓜ Fan Motor Location

* 4¼" on VXI 9
4¾" on VXI 18, 27, 36
** 3 MPT ON VXI 9
4 MPT ON VXI 18, 27, 36

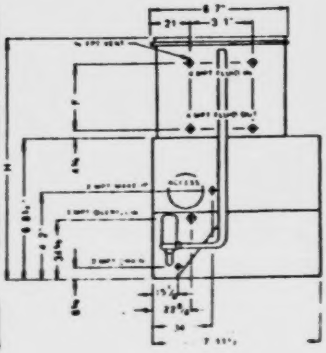

Model VXI 36
M
11½"
12'0"

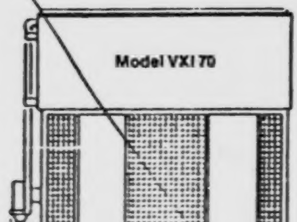
Model VXI 50 only

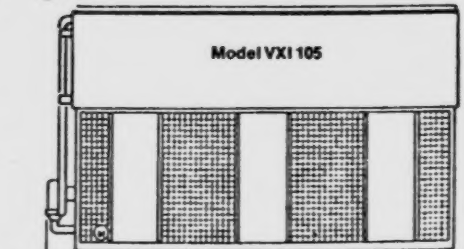



Model VXI 50
M
11½"
12'1⅛"

Model VXI 70-105


21
3' 1"
ACCESS
H
34
7' 11½


Model VXI 70
M
16
11'7¾"


Model VXI 105
M
20"
17'8"

5

NOTES:

1. The standard right hand arrangement as shown has the air inlet side on the right when facing the connection end. Left hand arrangement can be furnished by special order.

2. The recirculating water connections, coil connections and overflow connections are always located on the same end of the unit.

3. All location dimensions for coil connections are approximate and should not be used for prefabrication of connecting piping.

4. If discharge hoods with positive closure dampers are furnished, consult B.A.C. representative for added weight and height. Use next larger fan motor size for the additional external static pressure.

5. Coil section is normally the heaviest section. * Indicates unit ships in one piece.

6. For external static pressures up to ½" use next larger motor size.

7. When the flow rate on model VXI 50 exceeds 480 gpm, the quantity of coil connections will double.

8. For indoor application of VXI Industrial Fluid Coolers, the room may be used as a plenum with ductwork attached to the discharge only. If inlet ductwork is required an enclosed fan section must be specified; consult your B.A.C. representative for details.

9. Models VXI-9 thru 105 are single coil section units. Fan cycling results only in on-off operation. For additional steps of control, two-speed fan motors are available. More precise capacity control can be obtained with modulating fan discharge dampers (see page 28 for details).

	WEIGHTS [4, 5]							COIL CONNECT. [5, 7]		
MODEL NO.	APPROX. SHPG.	APPROX. OPER.	HEAVIEST SECTION	SPRAY PUMP GPM	CFM	FAN MOTOR HP [4, 6]	PUMP MOTOR HP	SIZE	F DIMENSION	H DIMENSION
VXI 9-1	1,460	1,710	1,460*	35	4,900	2	⅓	3	25¼	88½
VXI 9-2	1,620	1,910	1,000	35	4,700	2	⅓	3	34¾	98
VXI 9-3	1,820	2,150	1,180	35	5,200	3	⅓	3	44¼	107½
VXI 18-0	2,020	2,480	2,020*	75	9,700	5	½	4	14¾	79
VXI 18-1	2,260	2,800	2,260*	75	10,500	5	½	4	24¼	88½
VXI 18-2	2,560	3,180	1,650	75	10,200	5	½	4	33¾	98
VXI 18-3	2,930	3,650	2,010	75	11,600	7½	½	4	43¼	107½
VXI 27-1	3,110	4,080	3,110*	115	16,000	7½	¾	4	27¼	91½
VXI 27-2	3,580	4,690	2,470	115	14,500	7½	¾	4	37¾	102
VXI 27-3	4,020	5,280	2,850	115	15,000	10	¾	4	48¼	112½
VXI 36-2	4,530	6,050	3,140	150	22,000	10	1	4	37¾	102
VXI 36-3	5,140	6,850	3,720	150	23,000	15	1	4	48¼	112½
VXI 50-1	6,600	8,730	4,000	220	33,000	15	1½	4	27¼	111⅞
VXI 50-2	7,530	9,890	4,920	220	31,000	15	1½	4	37¾	122⅜
VXI 50-3	8,170	11,100	5,930	220	33,300	15	1½	4	48¼	132⅞
VXI 70-1	8,890	13,470	5,320	305	38,000	15	3	4	27¼	128⅛
VXI 70-2	10,180	15,130	6,580	305	44,000	20	3	4	37¾	138⅝
VXI 70-3	11,650	16,980	7,950	305	48,500	25	3	4	48¼	149⅛
VXI 105-1	13,250	19,940	8,340	460	72,000	30	5	4	27¼	128⅛
VXI 105-2	15,100	22,360	10,320	460	71,000	30	5	4	37¾	138⅝
VXI 105-3	17,140	24,970	12,270	460	68,000	30	5	4	48¼	149⅛

4.8 CONTROL EQUIPMENT

481 ANALOG CONTROLS

With reference to Plate 4, the following analog controls shall be furnished with the logic basically following the N.F.P.A. Code 85.

.1 Primary and loop seal air flows shall be summed to give total combustion air flow. The ratio of air to the combustion chamber to total air shall be set by the operator.

.2 Coal feed shall be measured by load cell/screw conveyor or weigh feeder with a variable speed drive. Feedrate shall be set by Master set point or by minimum air flow.

.3 Limestone feed shall be measured and varied in the same manner as the coal. Feedrate shall be set by the operator as a ratio of the coal feed or to achieve desired SO_2 level in the flue gas.

.4 Fuel/Air feed cross limiting shall be included, with the facility for the addition of oxygen trimming, should this be required.

.5 Fine adjustment of cooling of the combustor shall be effected by control of water through the bayonet tubes in response to the average of several temperature measurements in the gas stream and in the inlet or outlet water temperature.

.6 Pressure control shall be achieved via the I.D. fan suction damper.

.7 Flue gas cooler temperature control shall be effected by varying the water flow through the tubes. A bypass shall be provided around the control valve to ensure that no pressure or steam build-up can occur behind a closed valve.

482 CONTROL LOOPS

The following separate control loops shall be provided:

.1 The cooling fluid (water/glycol) shall be conditioned by a roof mounted air/fluid cooler in a circuit with pressure and temperature control valves.

.2 The ignition burner shall be furnished as a package with full start-up controls and flame failure safeguards conforming to NFPA codes.

On start-up all air dampers shall be in position to allow an uninterrupted air flow from F.D. to I.D. Fan. An interlock shall prevent ignitor light off until completion of a five minute purge.

A fuel trip shall be initiated if:

- either fan stops
- furnace pressure is high
- no coal or gas flow
- trip button is pushed

483 ALARMS

The following alarms shall be included:

- F.D. or I.D. Fan Trip
- Furnace Pressure High/Low
- Coal Feeder Trip
- Ignition burner trouble
- Low Air Flow
- O_2 High/Low
- SO_2 high
- CO_2 High
- Low fuel weight with feeder running
- Dust collector differential high
- Cooling water pump discharge pressure low
- Cooling water temperature high

484 HARDWARE

The control shall be based on a microprocessor such as Westinghouse 1500 or Micom P200. All field instruments shall be suitable for Class II Division 1 of the Canadian Electrical Code.

The controller, indicating instruments and alarms will be mounted in a purged control panel as shown in Plate 5, located adjacent to the coal feeders.

4.9 ELECTRICAL EQUIPMENT

All electrical equipment located on or adjacent to the rig shall be approved for use in a Class II, Division 2 area. Wiring shall be PVC jacketed type TECK or conduit and utilize sealed fillings approved for a Class II, Division 2 area.

The motor control centre shall be located in an area not subject to coal dust and shall comply with the following parameters:

- 600 Volt, 3-phase, 3 wire, 60 Hz.
- Class 1, type B wiring.
- EEMAC type 12 enclosure.
- 600A main bus, 300A vertical buses.
- Braced for 42 kA symmetrical.

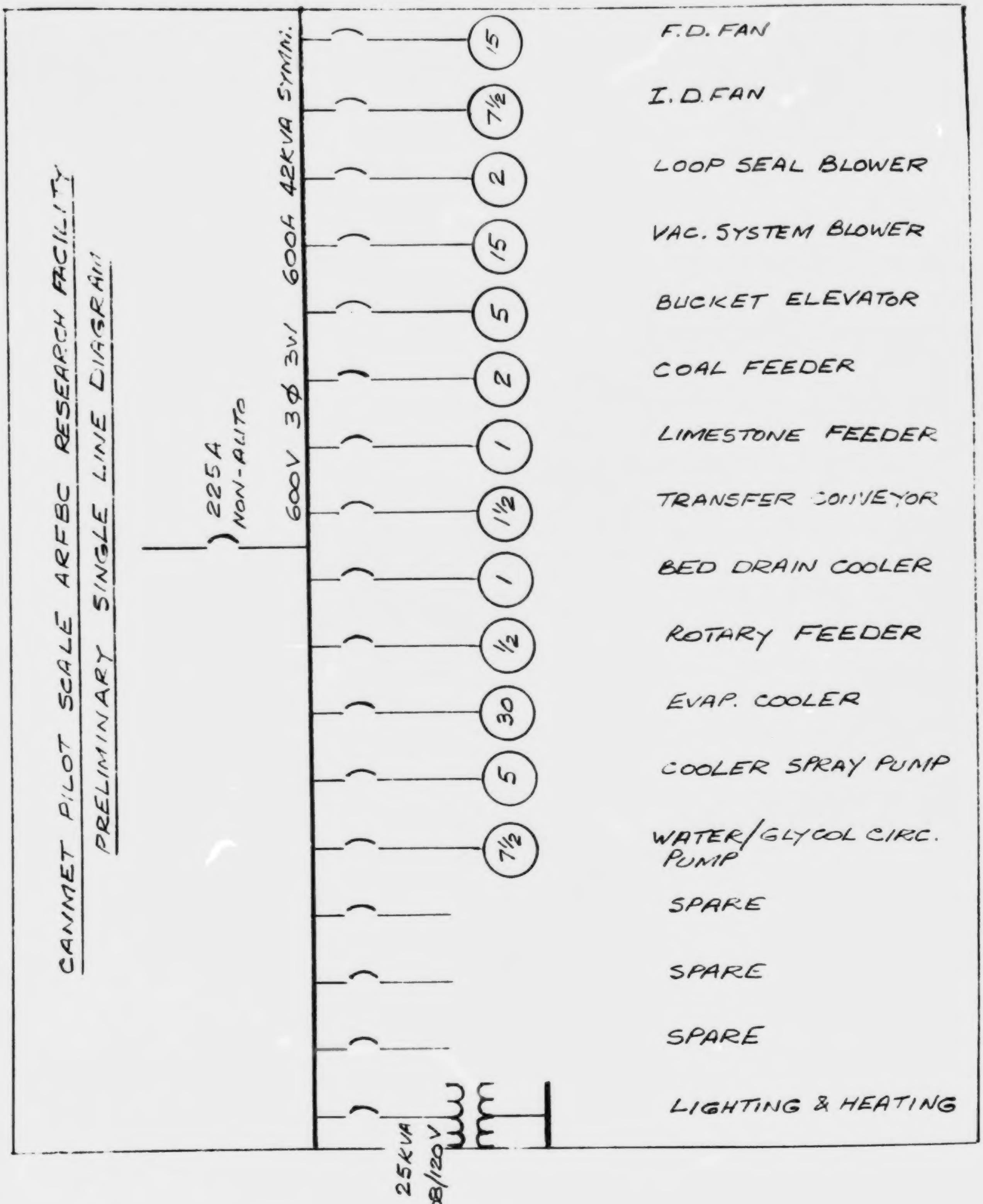
Provision shall be made for the following items:

- 225A main breaker (non-auto).
- 100A branch breaker.
- 25 kVa lighting transformer.
- 24 cct lighting panelboard.
- 13 size 1 FVNR combination starters.

- 2 size 2 FVNR combination starters.
- 1 size 3 FVNR combination starter.

A preliminary single line diagram, SK-1 is shown overleaf.

5K-1



CANMET PILOT SCALE AFBC RESEARCH FACILITY

PRELIMINARY SINGLE LINE DIAGRAM

600V 3φ 3W 600A 42KVA SYMM.
225A NON-AUTO
15
F.D. FAN
7½
I. D. FAN
2
LOOP SEAL BLOWER
15
VAC. SYSTEM BLOWER
5
BUCKET ELEVATOR
2
COAL FEEDER
1
LIMESTONE FEEDER
1½
TRANSFER CONVEYOR
1
BED DRAIN COOLER
½
ROTARY FEEDER
30
EVAP. COOLER
5
COOLER SPRAY PUMP
7½
WATER/GLYCOL CIRC. PUMP
SPARE
SPARE
SPARE
LIGHTING & HEATING
25KVA
208/120V

montreal engineering company, limited

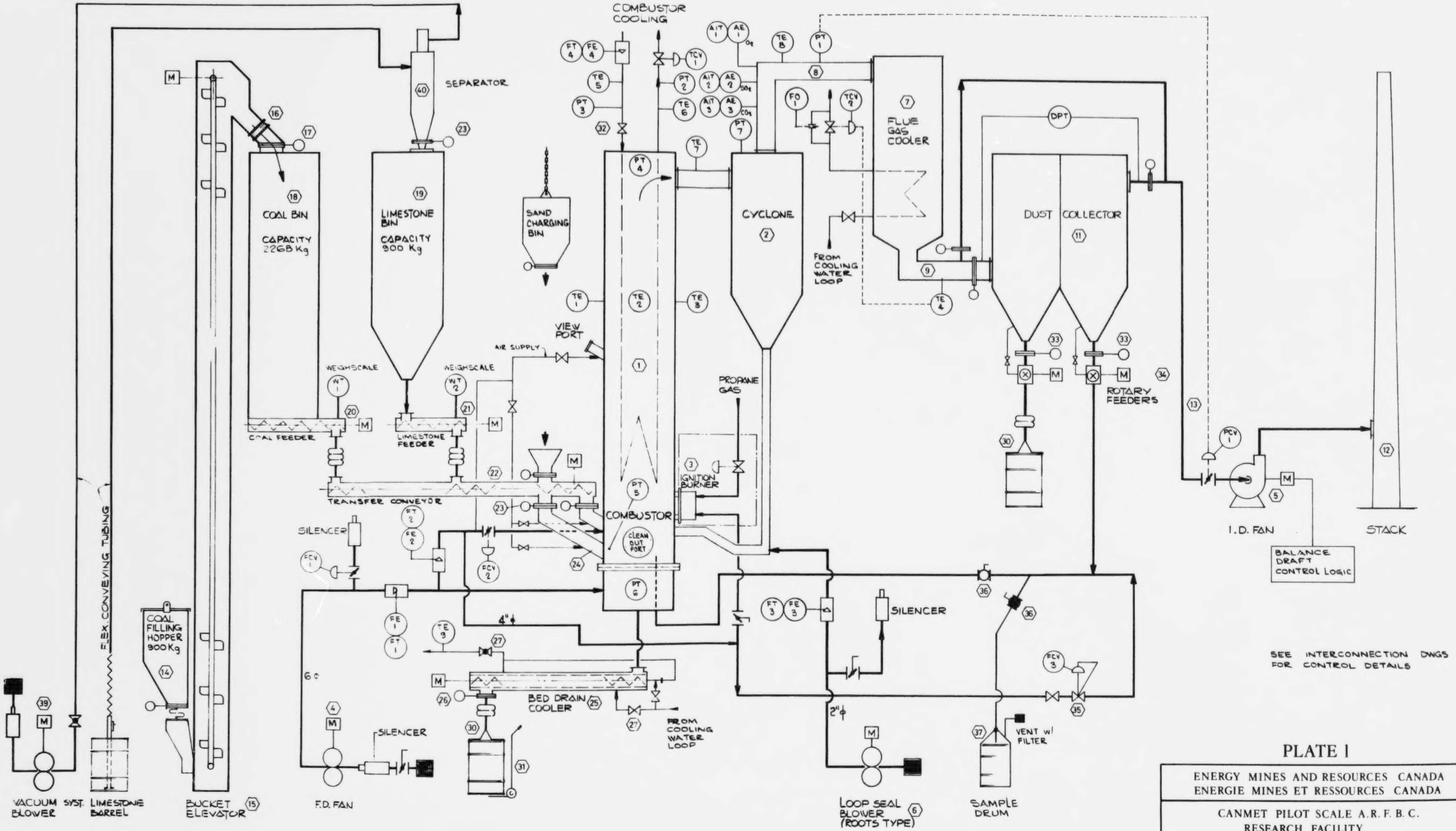

COMBUSTOR COOLING
SEPARATOR
40
16
17
23
COAL BIN
18
CAPACITY 2268 Kg
LIMESTONE BIN
19
CAPACITY 900 Kg
SAND CHARGING BIN
WEIGHSCALE
WT 1
WT 2
20
21
COAL FEEDER
LIMESTONE FEEDER
22
TRANSFER CONVEYOR
AIR SUPPLY
VIEW PORT
FT 4
FE 4
TE 5
PT 3
32
TCV 1
PT 2
TE 6
AIT 1
AE 1
AIT 2
AE 2
AIT 3
AE 3
O_2
SO_2
CO_2
TE B
PT 1
8
TE 7
PT 7
PT 4
TE 1
TE 2
TE 3
1
PT 5
COMBUSTOR
CLEAN OUT PORT
PT 6
3
IGNITION BURNER
PROPANE GAS
CYCLONE
2
FO 1
TCV 2
7
FLUE GAS COOLER
FROM COOLING WATER LOOP
9
TE 4
DPT
DUST COLLECTOR
11
33
M
ROTARY FEEDERS
34
30
13
PCV 1
5
I.D. FAN
BALANCE DRAFT CONTROL LOGIC
12
STACK
SILENCER
FCV 1
FT 2
FE 2
FCV 2
23
24
FE 1
FT 1
4" ϕ
TE 9
27
BED DRAIN COOLER
25
26
27
FROM COOLING WATER LOOP
30
31
6 ϕ
4
SILENCER
F.D. FAN
FT 3
FE 3
SILENCER
2" ϕ
LOOP SEAL BLOWER (ROOTS TYPE)
6
36
36
FCV 3
35
37
VENT W/ FILTER
SAMPLE DRUM
VACUUM SYST. BLOWER
39
LIMESTONE BARREL
FLEX. CONVEYING TUBING
COAL FILLING HOPPER 900 Kg
14
BUCKET ELEVATOR
15
SEE INTERCONNECTION DWGS FOR CONTROL DETAILS

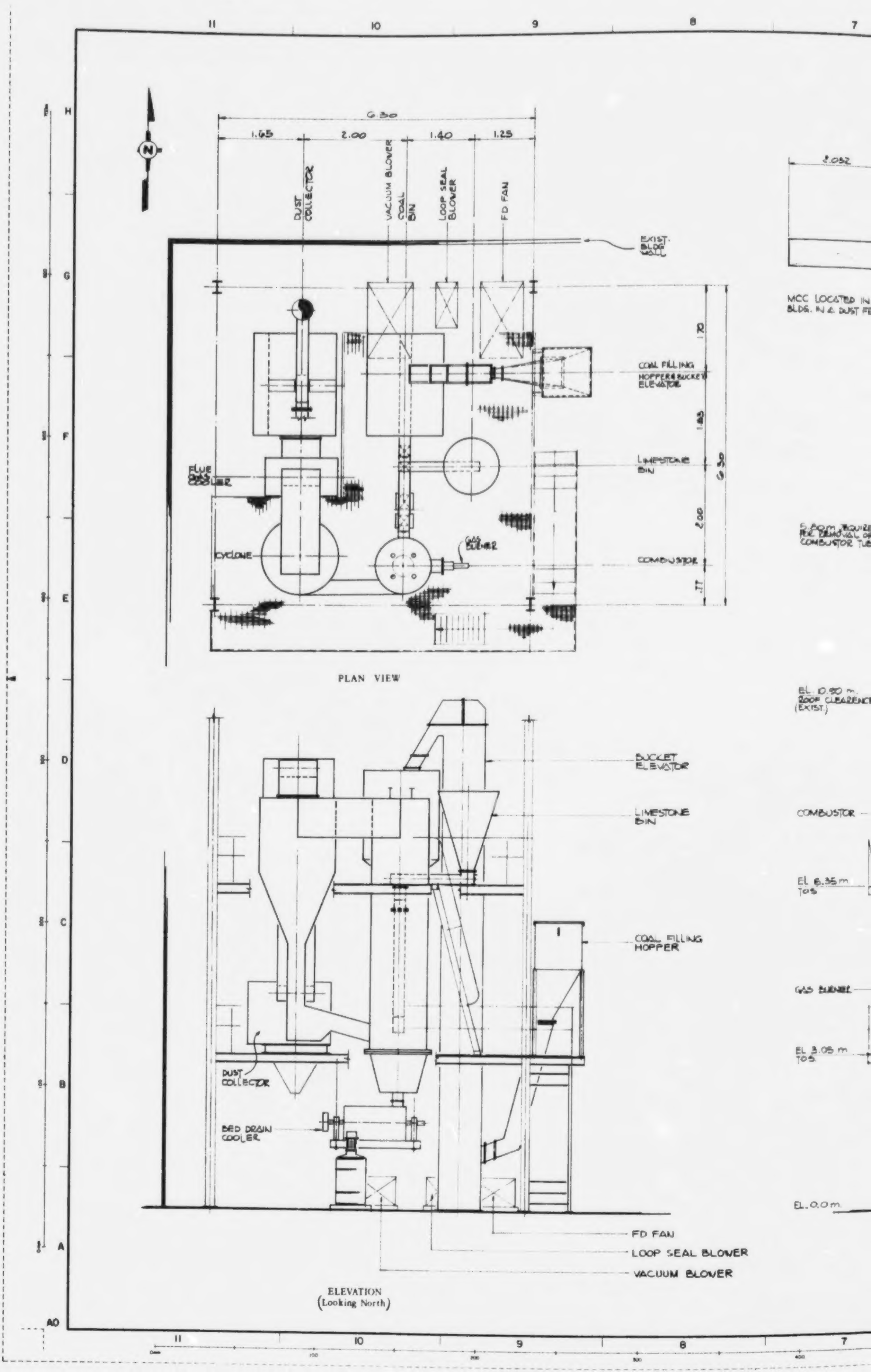
PLATE I

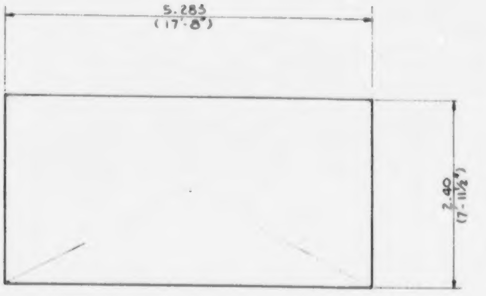
ENERGY MINES AND RESOURCES CANADA
ENERGIE MINES ET RESSOURCES CANADA

CANMET PILOT SCALE A. R. F. B. C.
RESEARCH FACILITY

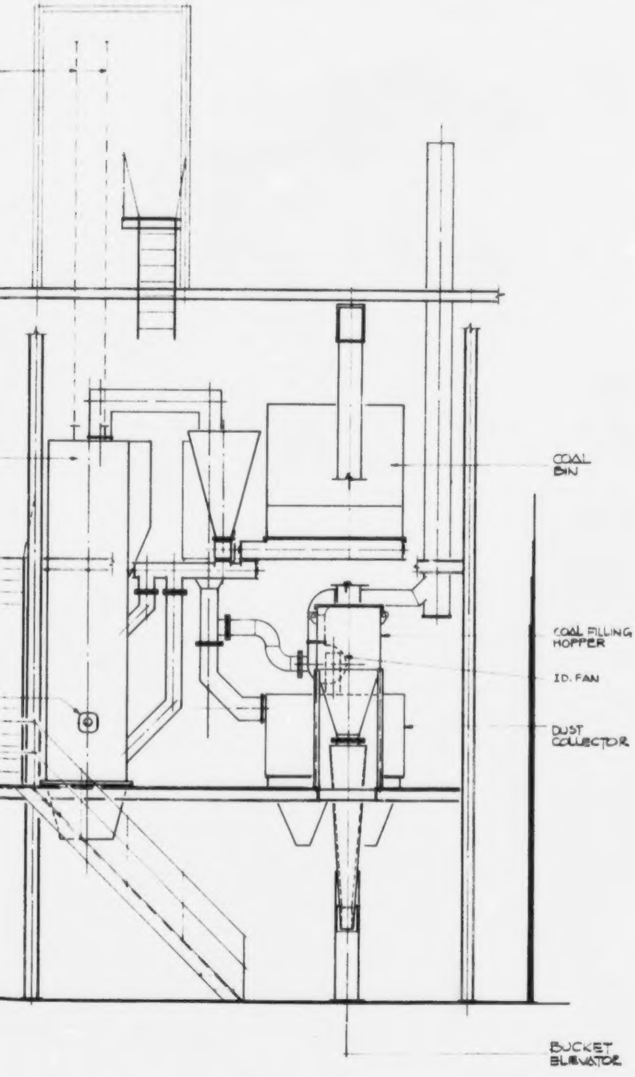
D.S.S. CONTRACT No. O S Q 81-00240

PROCESS FLOW DIAGRAM


11
10
9
8
7
H
G
F
E
D
C
B
A
A0
N
6.30
1.65
2.00
1.40
1.25
DUST COLLECTOR
VACUUM BLOWER
COAL BIN
LOOP SEAL BLOWER
FD FAN
EXIST. BLDG WALL
COAL FILLING HOPPER & BUCKET ELEVATOR
1.85
LIMESTONE BIN
6.30
2.00
COMBUSTOR
.77
FLUE GAS COOLER
CYCLONE
GAS BURNER
PLAN VIEW
2.032
MCC LOCATED IN
BLDG. IN A DUST FR
5.80 m REQUIRE
FOR REMOVAL OF
COMBUSTOR TUB
EL 10.90 m.
ROOF CLEARENCE
(EXIST.)
BUCKET ELEVATOR
LIMESTONE BIN
COMBUSTOR
EL 6.35 m
TOS
COAL FILLING HOPPER
GAS BURNER
EL 3.05 m
TOS
DUST COLLECTOR
BED DRAIN COOLER
EL. 0.0 m.
FD FAN
LOOP SEAL BLOWER
VACUUM BLOWER
ELEVATION
(Looking North)


5.285
(17'-8")
2.40
(7'-11½")

OUTDOOR (ROOF MOUNTED)
AIR/WATER GLYCOL COOLER
3.50 HIGH (11'-6")


COAL
BIN
COAL FILLING
HOPPER
I.D. FAN
DUST
COLLECTOR
BUCKET
ELEVATOR

ELEVATION
(Looking West)

NOTES

1) FOR CLARITY CONTROL CUBICLE NOT SHOWN ON OPERATING FLOOR

2) FOR CLARITY SOME EQUIPMENT AND OR STRUCTURE AS BEEN SHOWN IN ONLY ONE VIEW

3) THE INFORMATIONS CONTAINED ARE PRELIMINARY ONLY. THEY REPPRESENT MINIMUM REQUIREMENTS AND HAVE TO BE VERIFIED BY THE CONTRACTOR IN HIS DETAILED DESIGN AND LAYOUT.

PLATE 2

ENERGY MINES AND RESOURCES CANADA
ENERGIE MINES ET RESSOURCES CANADA

CANMET PILOT SCALE A.R.F.B.C.
RESEARCH FACILITY

D.S.S. CONTRACT No. OSQ 81-00240

CONCEPTUAL DESIGN LAYOUT

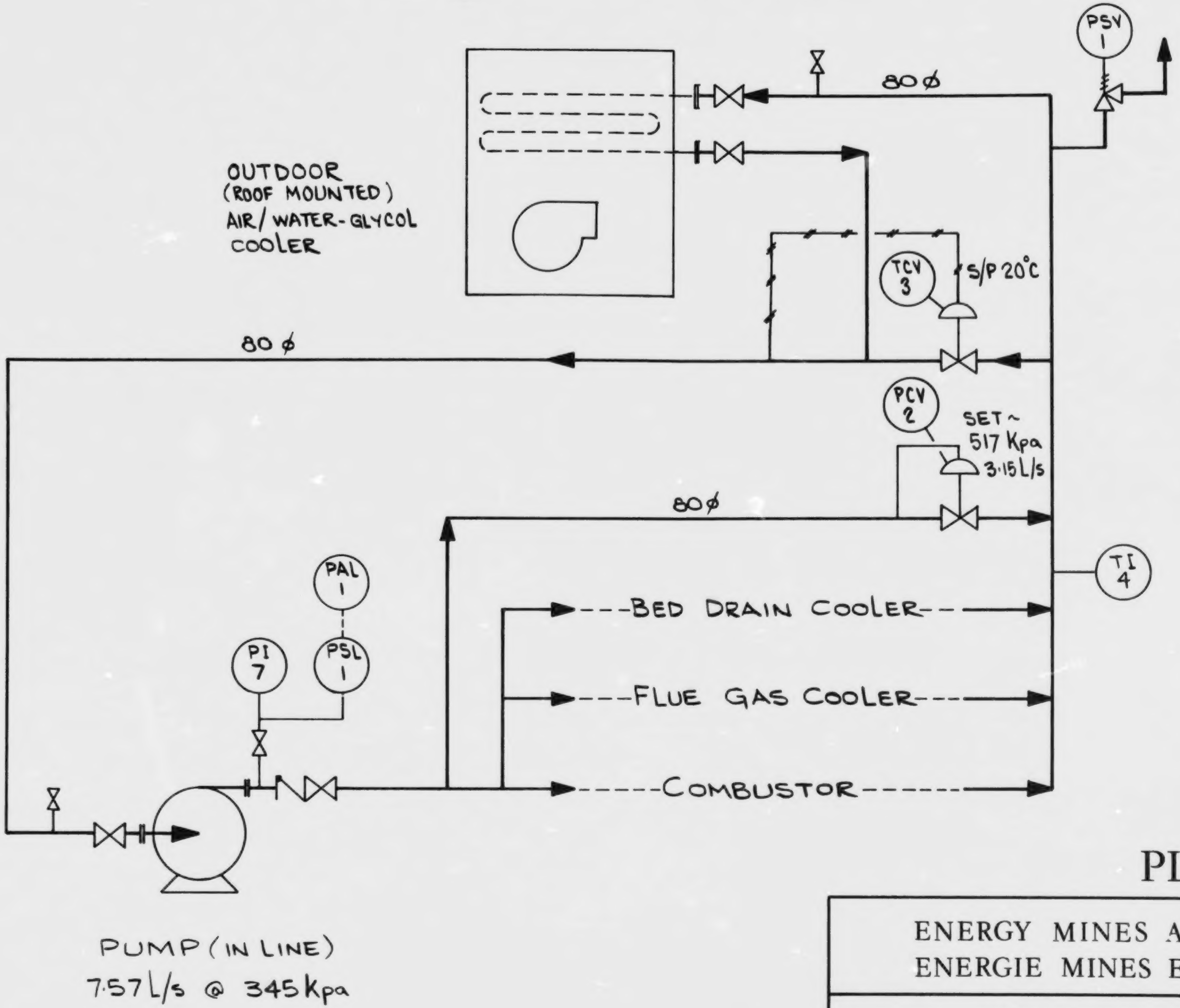

PSV 1
80 ø
OUTDOOR
(ROOF MOUNTED)
AIR/WATER-GLYCOL
COOLER
TCV 3
S/P 20°C
80 ø
PCV 2
SET ~
517 Kpa
3.15 L/s
80 ø
TI 4
PAL 1
PI 7
PSL 1
BED DRAIN COOLER
FLUE GAS COOLER
COMBUSTOR
PUMP (IN LINE)
7.57 L/s @ 345 Kpa

PLATE 3

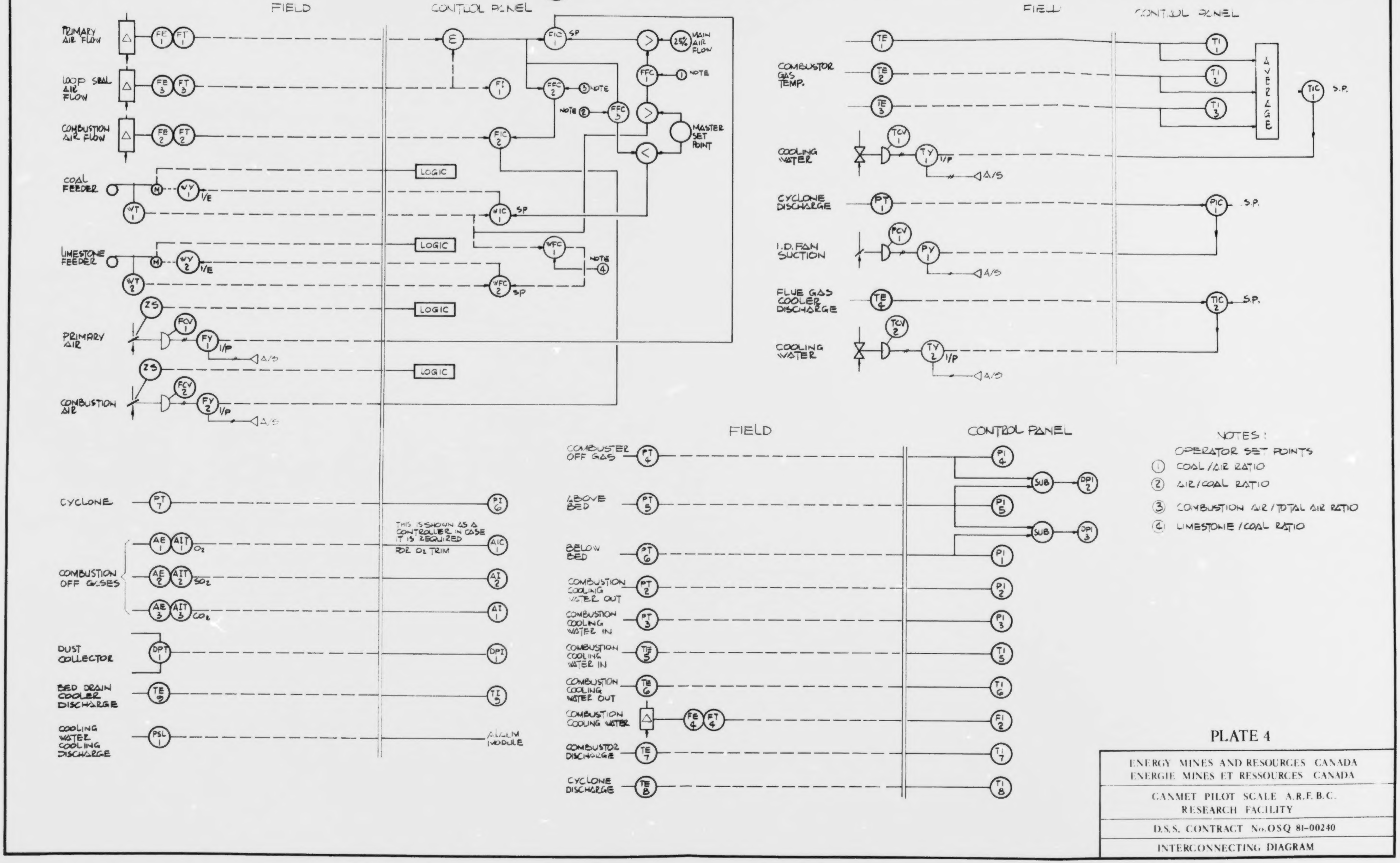
ENERGY MINES AND RESOURCES CANADA
ENERGIE MINES ET RESSOURCES CANADA

CANMET PILOT SCALE A.R.F.B.C.
RESEARCH FACILITY

D.S.S. CONTRACT No. OSQ 81-00240

COOLING WATER FLOW DIAGRAM

montreal engineering company, limited


FIELD
CONTROL PANEL
PRIMARY AIR FLOW
FE 1
FT 1
LOOP SEAL AIR FLOW
FE 3
FT 3
COMBUSTION AIR FLOW
FE 2
FT 2
Σ
FI 1
FIC 1
SP
FIC 2
FFC 2
FFC 3
FFC 1
3 NOTE
NOTE 2
1 NOTE
25%
MAIN AIR FLOW
MASTER SET POINT
COAL FEEDER
M
WY 1
I/E
WT 1
WIC 1
SP
LOGIC
LIMESTONE FEEDER
WY 2
I/E
WT 2
WFC 1
WFC 2
SP
NOTE 4
ZS
PRIMARY AIR
FCV 1
FY 1
I/P
A/S
COMBUSTION AIR
FCV 2
FY 2
I/P
A/S
CYCLONE
PT 7
PI 6
THIS IS SHOWN AS A CONTROLLER IN CASE IT IS REQUIRED FOR O2 TRIM
COMBUSTION OFF GASES
AE 1
AIT 1
O2
AIC 1
AE 2
AIT 2
SO2
AI 2
AE 3
AIT 3
CO2
AI 1
DUST COLLECTOR
DPT 1
DPI 1
BED DRAIN COOLER DISCHARGE
TE 9
TI 9
COOLING WATER COOLING DISCHARGE
PSL 1
ALARM MODULE
FIELD
CONTROL PANEL
COMBUSTOR GAS TEMP.
TE 1
TE 2
TE 3
TI 1
TI 2
TI 3
AVERAGE
TIC 1
S.P.
COOLING WATER
TCV 1
TY 1
I/P
A/S
CYCLONE DISCHARGE
PT 1
PIC 1
S.P.
I.D. FAN SUCTION
PCV 1
PY 1
A/S
FLUE GAS COOLER DISCHARGE
TE 4
TIC 2
S.P.
COOLING WATER
TCV 2
TY 2
I/P
A/S
FIELD
CONTROL PANEL
COMBUSTER OFF GAS
PT 4
PI 4
SUB
DPI 2
ABOVE BED
PT 5
PI 5
SUB
DPI 3
BELOW BED
PT 6
PI 1
COMBUSTION COOLING WATER OUT
PT 2
PI 2
COMBUSTION COOLING WATER IN
PT 3
PI 3
COMBUSTION COOLING WATER IN
TE 5
TI 5
COMBUSTION COOLING WATER OUT
TE 6
TI 6
COMBUSTION COOLING WATER
FE 4
FT 4
FI 2
COMBUSTOR DISCHARGE
TE 7
TI 7
CYCLONE DISCHARGE
TE 8
TI 8

NOTES:
OPERATOR SET POINTS
① COAL/AIR RATIO
② AIR/COAL RATIO
③ COMBUSTION AIR/TOTAL AIR RATIO
④ LIMESTONE/COAL RATIO

PLATE 4

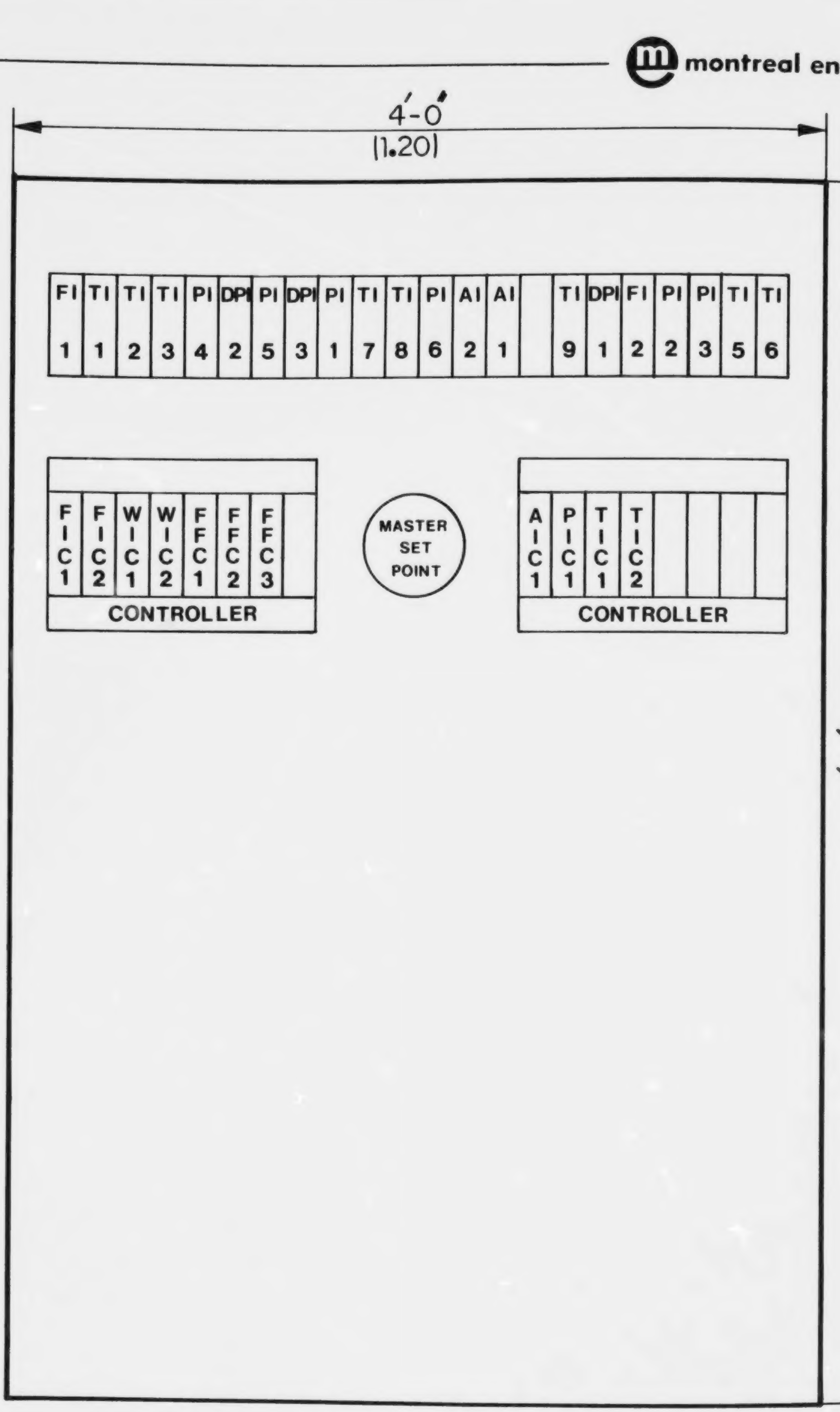
ENERGY MINES AND RESOURCES CANADA
ENERGIE MINES ET RESSOURCES CANADA

CANMET PILOT SCALE A.R.F.B.C.
RESEARCH FACILITY

D.S.S. CONTRACT No. OSQ 81-00240

INTERCONNECTING DIAGRAM

montreal en


4'-0"
(1.20)
FI 1
TI 1
TI 2
TI 3
PI 4
DPI 2
PI 5
DPI 3
PI 1
TI 7
TI 8
PI 6
AI 2
AI 1
TI 9
DPI 1
FI 2
PI 2
PI 3
TI 5
TI 6
FIC 1
FIC 2
WIC 1
WIC 2
FFC 1
FFC 2
FFC 3
CONTROLLER
MASTER SET POINT
AIC 1
PIC 1
TIC 1
TIC 2
CONTROLLER

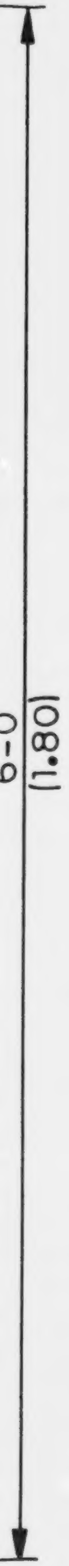


PLATE 5

ENERGY MINES AND RESOURCES CANADA
ENERGIE MINES ET RESSOURCES CANADA

CANMET PILOT SCALE A.R. F. B. C.
RESEARCH FACILITY

D.S.S. CONTRACT No.OSQ 81-00240

CONTROL PANEL

4.11 UTILITIES ESTIMATE

- Electrical Load	150 KVA
- Water Consumption, (open loop cooling $19 m^3/h$) closed loop cooling assumed to be maximum of 10% of open loop cooling	$1.9\ m^3/h$
- Compressed Air	40 std. m^3/h
- Propane (assuming 1 start per day)	30 Kg/day

PART 5

MATERIAL LIST

5.1 MATERIALS/EQUIPMENT LIST

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
1	Combustor	Pyropower	Weight: Nom 5440 kg Ref's: Pyropower report MECo specification
	Plus Personnel Protection Insulation	Installation Contractor	25 mm insulation external
2	Cyclone with Ducting/Recycle Loop	Pyropower	Weight: 6,350 kg
	Plus Personnel Protection Insl.	Installation Contractor	25 mm insulation, external
3	Ignition Burner c/w controls	Trecan	Note: Propane bottles by others.
4	F.D. Fan	Canadian Air Compressor	Power: 11 kW Outlet Press.: 28 kPa Flow: 260 l/s Speed: 2,750 rpm
5	I.D. Fan	Chicago Blower	Power: 5.5 kW Δ P: 530 mm W.G. Flow: 380 l/s (actual) Speed: 3,500 rpm

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
6	Loop Seal Blower	Canadian Air Compressor	Power: 1.5 kW P: 55 kPa Flow: 8 l/s (actual)
7	Flue Gas Cooler	Trecan or Fabricator	Heat Load: 300 kW Flue Gas Inlet Temp.: 871°C Flue Gas Outlet Temp.: 170°C Mass Flow: 0.38 kg/s Weight: approx. 1,587 kg Dims.: approx. 2 m wide x 0.76 m deep x 2.5 m high Cooling by water or water/glycol
8	Ducting: Cyclone to Flue Gas Cooler	Installation Contractor	Allow: 4.5 m of 1 m x 1 m duct, with 1 bend. Internal temperature 871°C so duct insulated to reduce outside temperature to 60°C. Thickness estimated: 0.2 m Internal pressure: - 500 mm W.G. max^{m}
9	Ducting: Flue Gas Cooler to Dust Collector	Installation Contractor	6 m of 1 m x 1 m duct Insulation thickness = 50 mm Including 1 bend Internal pressure: -508 mm W.G.
10	Flexible Joints in Ducts 8 and 9		2 flexible joints, 1 in each duct

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
11	Dust Collector	Sly	Flow Rate: 0.38 kg Temp.: 170°C Dust Load: 0.1 kg/m^3
12	Stack	Installation Contractor	Height: 15 m Diameter: 610 mm
13	Ducting from Dust Collector to Stack	Installation Contractor	10 m of 1 m x 1 m duct Include 2 flexible joints, reducers at I.D. Fan
14	Coal Filling Hopper	Fabricator	Cap. 900 kg
15	Bucket Elevator	Sullivan Strong Scott	10.7 m discharge height complete with 8 x 5 AA buckets Motor power 1.5 kW, Speed 1.2 m/s at 43 rpm, capacity 1 kg/s
16	Flexible Connection (Exit Bucket Elev.)		0.2 m square rubber joint with flanges
17	Slide Gate G1		0.2 x 0.3 m slide gate, manually operated. Carbon steel construction, to withstand Pressure of 500 mm W.G. Max. Temp. 65°C
18	Coal Bin	Fabricator	Capacity: 2,268 kg
19	Limestone Bin	Fabricator	Capacity: 900 kg

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
20	Coal Feeder	Sullivan Strong Scott	Conveyor with variable speed drive. Max. Capacity: 0.091 kg/s 100 mm diameter 3 m long (max.)
21	Limestone Feeder	Sullivan Strong Scott	Conveyor with variable speed drive. Max. Capacity: 0.017 kg/s 100 mm diameter 1.5 m long
22	Transfer Conveyor	Sullivan Strong Scott	Conveyor with constant speed drive. 150 mm diameter Max. Capacity: 0.126 kg/s
23	Slide Gate G2 G3 G4 G5 G6		0.2 m square slide gate Max. Pressure: 890 mm W.G. Carbon steel, manually operated Max. Temperature: 65°C except for two (G6, G5) which shall be good for 425°C.

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
24	Materials feed chutes (Total two)	Fabricator	Size: 150 mm diameter Carbon steel; with three 12 mm connections for air purge; 75 mm of insulation. Internal pressure: 890 mm W.G. Temperature max.: 425°C Chutes to be double skinned with inlet and outlet connections for cooling water, if required. Lengths: 1 m max. and 3 m max.
25	Bed Drain Cooler	Control & Metering Porcupine Processor	Variable speed cooled feeder Power: 0.75 kW Approx. Dim: 3 m x 0.7 m x 0.7 m Cooling medium: water Max. bed drain flowrate: 0.045 kg/s Temp. of bed drain: 870°C Outlet temp.: 150°C
26	Slide Gate/Outlet of Bed Drain Cooler		0.2 m square slide gate Carbon steel, manually operated Max. temp.: 204°C Max. pressure: 890 mm W.G.
27	Valves/piping/ fittings, etc. for Bed Drain Cooler		Allow, 4 - 50 mm globe valves Pressure: 350 kPa at 100°C 2 - check valves, 50 mm dia. 12 m of pipe, various fittings

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
28	Air Piping		Allow 76 m 150 mm pipe with 12 bends, 3 tees. 7 flange to flange connections, hangers, no insulation.
29	Small pipe < 65 mm		Allow 76 m 50 mm pipe, 12 bends, 3 tees, 7 flange/flange connections, hangers, no insulation.
30	Drum Covers	Fabricator	Total required: five suitable for 42 usg. drums
31	Hand Cart to Handle drums	McMaster-Carr	To handle materials in drums. Total required: three
32	Valves: Cooling Water		Four isolation valves. 50 mm globe valves. Pressure: 350 kPa Temperature: 100°C max. Screw connections.
33	Slide Gates		0.2 m square Temperature: 170°C Pressure: 508 mm W.G. Carbon steel construction, manually operated. Total: two
34	Rotary Feeder	Semco	Variable speed rotary valve to feed flyash for recycle.

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
35	Pressure Regulator with isolating valve (25 mm size)		Max. 7 l/s Inlet: 650 kPa max. Outlet: 28 kPa max. 14 kPa min. Complete with local P.I.
36	Ball Valves		25 mm diameter: two required Temp.: Max. 170°C Carbon steel construction, hand operated.
37	Drum Cover (modified) 1 req'd.		Suitable for 42 usg. drum filter sized for 5 l/s.
38	Miscellaneous reinforced rubber hoses, plastic tubes		
39	Limestone, Vacuum Syst. Blower		11 kW (Estimated) Roots Type Blower
40	Limestone Vacuum System with Separator, Tubing & Suction Wand	Control and Metering Ltd.	Capacity: 2,720 kg/hr
41	Cooling System, Air Cooler	Baltimore Air Cooler	Rated: 733 kW Air temp.: 30°C Fluid: Water/Glycol

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
42	Cooling System, Pump		350 kPa at 8 l/s In-line pump. flanged 125 lb. F.F. Construction cast iron, Bronze impeller Temperature: 30°C
43	Temperature Control Valve		50 mm complete with temperature sensor (capillary tube) and direct acting operator Rated 8 l/s at 200 kPa ΔP at 24°C setpoint
44	Pressure Control Valve		50 mm size Rated 4 l/s at 500 kPa complete with direct acting operator
45	Valves & Piping		60 m, 75 mm line: 12 bends, 4 tees, 8 flanged connections, hangers, etc. Temperature: max. 100°C Pressure: 350 kPa
46	Silencers F.D. Fan & Loop Seal Blower		
47	Instrumentation and Controls		

IT/REF.	DESCRIPTION	SUPPLIER	MISC. DATA
48	Control Cubicle		1.2 m wide x 1.8 m high, air purged
49	Support Steel plus railings, gratings, kickplates, painting, erection, stairs, etc.		
50	Concrete/Rebar and Installation		
51	Miscellaneous Dampers and Control Valves		
52	Roof Enclosure with lifting tackle for removal of bayonet tubes from combustor		
53	Motor Starters		
54	Miscellaneous elect, cables, distribution panel, on/off switches, JB's, etc.		

PART 6

COST ESTIMATE

6.1 COST ESTIMATES

611 INTRODUCTION

The equipment costs used in the budgetary estimate are based either upon pricing from suppliers or on in-house historical data.

Erection costs are estimates from in-house data based on the Materials/Equipment List included in Section 5.1.

The engineering estimate recognizes that the early stages will involve a fairly intensive engineering commitment in order to select compatible systems, equipment and interfaces for the combustor cooling circuits and material handling. The cost estimate is predicated on purchasing commercially available components and connecting these together to form the required facility. It is not envisaged that any equipment is to be developed specifically for this rig.

The budgetary engineering cost estimate is based on the following assumptions:

- Monenco will engineer, procure and supervise the construction of the complete facility as per the preliminary schedule in Part 7.

- Detailed engineering will be followed by a Client Design Review

- Alternate Canadian sources of foreign made equipment will be investigated

- Purchasing of equipment will be performed using Montreal Engineering "Engineering Requisition", MECo form No. 12-023-1. Three copies of all requisitions, purchase orders, change orders, invoices and payments being sent to the DSS at time of instigation.

- A senior mechanical engineer will act as project leader with full time commitment through design finalization, detail design, procurement and manufacture. Thereafter, two alternatives may be considered:

  a) Full time supervision by Monenco during construction and commissioning.

  b) Minimal, part-time Monenco involvement on site during construction and commissioning. This alternative would necessitate Canmet appointing a full time supervision during site activities.

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 DATE JULY 1982 ESTIMATED BY T.A.G. PAGE 1 OF

ACCOUNT No.	QUANTITY	UNIT	DESCRIPTION		UNIT COST	TOTALS IN:	
1 & 2	1	EA	COMBUSTOR & CYCLONE	SUPPLY		375,000	
			300 MHRS	INSTALL		10,500	
3	1	EA	IGNITION BURNER C/W CONTROLS	SUPPLY		12,000	
			50 MHRS	INSTALL		1,750	
4	1	EA	FD FAN	SUPPLY		8,600	
			8 MHRS	INSTALL		280	
5	1	EA	ID FAN	SUPPLY		3,200	
			8 MHRS	INSTALL		280	
6	1	EA	LOOP SEAL BLOWER	SUPPLY		1,950	
			8 MHRS	INSTALL		280	
7	1	EA	FLUE GAS COOLER	SUPPLY		24,500	
			16 MHRS	INSTALL		560	

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 DATE JULY 1982 ESTIMATED BY PAGE 2 OF

ACCOUNT No.	QUANTITY	UNIT	DESCRIPTION		UNIT COST	TOTALS IN:	
8	Equiv. 28	M^2	DUCT: CYCLONE TO FLUE GAS COOLER	S & I	500	14,000	
	28	M^2	INSULATION	S & I	600	16,800	
9	Equiv. 34	M^2	DUCTING: FGC TO DUST COLL.	S & I	500	17,000	
10	4	EA	FLEXIBLE JOINTS	S & I	1,500	6,000	
11	1	EA	DUST COLLECTOR	SUPPLY		25,150	
			100 MHRS	INSTALL		3,500	
12	1	EA	STACK	SUPPLY		10,000	
			50 MHRS	INSTALL		1,750	
13	Equiv 20	M^2	DUCTING: DUST COLLECTOR TO STACK	S & I	500	10,000	
14	2	EA	COAL FILLING HOPPER	SUPPLY	6,000	12,000	

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 DATE JULY 1982 ESTIMATED BY PAGE 3 OF

ACCOUNT No.	QUANTITY	UNIT	DESCRIPTION		UNIT COST	TOTALS IN:	
15	1	EA	BUCKET ELEVATOR	SUPPLY		13,700	
			40 MHRS	INSTALL		1,400	
16	1	EA	FLEX. CONN. AT BUCKET ELEV. EXIT	S & I		500	
17	1	EA	SLIDE GATE	S & I		1,000	
18	1	EA	COAL BIN	S & I		15,000	
19	1	EA	LIMESTONE BIN	S & I		5,500	
20	1	EA	COAL FEEDER	SUPPLY		4,900	
			10 MHRS	INSTALL		350	
21	1	EA	LIMESTONE FEEDER	SUPPLY		3,900	
			10 MHRS	INSTALL		350	

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 DATE JULY 1982 ESTIMATED BY T.A.G. PAGE 4 OF

ACCOUNT No.	QUANTITY	UNIT	DESCRIPTION		UNIT COST	TOTALS IN:	
22	1	EA	TRANSFER CONVEYOR	SUPPLY		2,800	
			10 MHRS	INSTALL		350	
23	5	EA.	SLIDE GATE	S & I	1,500	7,500	
24	2	EA.	CHUTES	S & I	2,500	5,000	
25	1	EA.	BED DRAIN COOLER W. SUPPT. STL.	SUPPLY		40,500	
			10 MHRS	INSTALL		350	
26	1	EA	SLIDE GATE (FOR ITEM 25)	S & I		1,000	
27	13	M	2" STD. WT. PIPE C/W V & FITTINGS	S & I	100	1,300	
28	81	M	6" STD. WT. PIPE C/W V & FITTINGS	S & I	200	16,250	
29	81	M	2" STD. WT. PIPE C/W V & FITTINGS	S & I	100	8,100	

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 **DATE** JULY 1982 **ESTIMATED BY** T.A.G. **PAGE** 5 **OF**

ACCOUNT NO.	QUANTITY	UNIT	DESCRIPTION		UNIT COST	TOTALS IN:	
30	5	EA	DRUM COVERS WITH FLEX. CONN.	SUPPLY	400	2,000	
31	3	EA	HAND CART	SUPPLY	250	750	
32	4	EA	2" LOW PRESS GLOBE VALVES	S & I	350	1,400	
33	2	EA.	SLIDE GATES	S & I	1,000	2,000	
34	2	EA.	ROTARY FEEDER	SUPPLY	4,000	8,000	
			4 MHRS	INSTALL		140	
35	1	EA.	PRESSURE REGULATOR	S & I		600	
36	2	EA.	BALL VALVE	S & I	200	400	
37	1	EA.	DRUM COVER C/W VENT & FILTER	SUPPLY		700	

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 **DATE** JULY 1982 **ESTIMATED BY** T.A.G. **PAGE** 6 **OF**

ACCOUNT NO.	QUANTITY	UNIT	DESCRIPTION		UNIT COST	TOTALS IN:	
38	1	SET	HOSES & TUBES	SUPPLY		2,500	
39	1	EACH	LIMESTONE, VAC. SYST. BLOWER	SUPPLY		3,000	
			8 MHRS	INSTALL		280	
40	1	EA.	VACUUM SYSTEM: SEPARATOR	SUPPLY		6,000	
			10 MHRS	INSTALL		350	
41	1	EA.	COOLING SYSTEM: COOLER	SUPPLY		30,500	
			25 MHRS + CRANE	INSTALL		2,000	
42	1	EA.	PUMP: FOR ITEM 41	SUPPLY		2,500	
			4 MHRS	INSTALL		140	
43	1	EA.	TEMP. CONTROL VALVE	SUPPLY		500	
			4 MHRS	INSTALL		140	

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 **DATE** JULY 1982 **ESTIMATED BY** T.A.G. **PAGE** 7 **OF**

ACCOUNT No.	QUANTITY	UNIT	DESCRIPTION		UNIT COST	TOTALS IN:	
44	1	EA.	PRESS.CONTROL VALVE	SUPPLY		500	
			4 MHRS	INSTALL		140	
45	65	M	3" STD. WT. PIPE C/W V & FITTINGS	S & I	150	9,750.	
46	2	EA.	SILENCER	SUPPLY	500	1,000	
			4 MHRS	INSTALL		140	
47	1	SET	I & C	S & I		130,000	
48	1	EA.	CONTROL CUBICLE	SUPPLY		5,600	
			40 MHRS	INSTALL		1,400	
49			STRUCTURAL STEEL:				
	11	T	MAIN STRUCTURE	S & I	2,000	22,000	
	8	T	BRACING & TRIM	S & I	2,500	20,000	

MECO 12-062B (REV 2/77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 **DATE** JULY 1982 **ESTIMATED BY** T.A.G. **PAGE** 8 **OF**

ACCOUNT No.	QUANTITY	UNIT	DESCRIPTION		UNIT COST	TOTALS IN:	
50	8	M^3	CONCRETE IN PLACE	S & I	400	3,200	
51			MISC. DAMPERS & CONTROL VALVES	S & I		5,000	
52			ROOF ENCLOSURE	S & I		5,000	
53	1	SET	MOTOR STARTERS (INCL. IN ITEM 54)				
54	1	SET	ELECT. EQUIP.	S & I		35,000	
55	38	M^2	FAN ENCLOSURE: ACOUSTICAL PANELS INCL. DOOR ASSUME 4" THK.	S & I	250	9,500	
56	1	EA.	SAND CHARGING BIN	SUPPLY		1,000	
57	EQUIV. 10	M^2	DUST COLLECTOR BY-PASS	S & I	500	5,000	

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 DATE JULY 1982 ESTIMATED BY T.A.G. PAGE 9 OF

ACCOUNT No.	QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTALS IN:	
			SUMMARY OF EQUIPMENT AND INSTALLATION COST			
			CIVIL WORKS (ITEMS 49, 50 & 52)		50,200	
			ELECTRICAL EQUIPMENT (ITEMS 53 & 54)		35,000	
			I & C (ITEM 47)		130,000	
			MECHANICAL EQUIPMENT (ALL OTHER ITEMS)		787,800	
			TOTAL (ROUNDED)			1,003,000
			O.R.S.T. & FREIGHT ON EQUIP.			40,000
			CONTINGENCY			47,000
			EQUIPMENT & INSTALLATION COSTS: TOTAL			1,090,000
			ENGINEERING COSTS (INCLUDING SITE SUPERVISION)			190,000
			TOTAL COST OF PROJECT			1,280,000
			COST OF PROJECT WITH SITE SUPERVISION PROVIDED BY CANMET			1,240,000

MECO 12-062B (REV 2 77)

MONTREAL ENGINEERING COMPANY, LIMITED

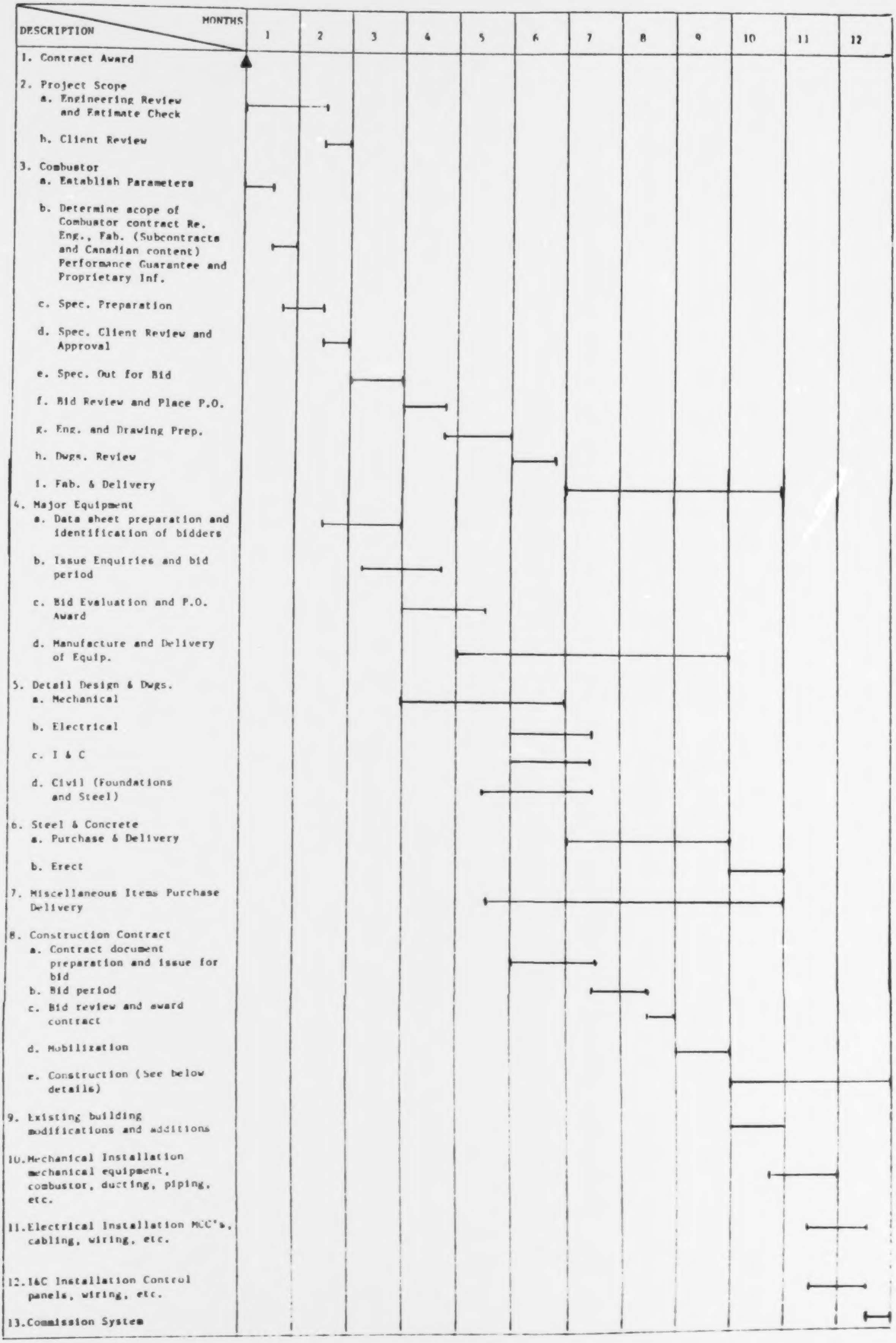
ESTIMATE OF CANMET A.R.F.B.C. PILOT PLANT

FILE DSS 7914-9 **DATE** **ESTIMATED BY** T.A.G. **PAGE** 10 **OF**

ACCOUNT No.	QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTALS IN:	
			ITEM 47: I & C DETAILS			
	2	EA	BIN WEIGHING SYSTEM	5,000	10,000	
	8	EA	TRANSMITTERS	1,400	11,200	
	4	EA	VORTEX METER	3,000	12,000	
	9	EA	THERMOCOUPLE	200	1,800	
	3	EA	ANALYSER	12,000	36,000	
	1	SET	CONTROL VALVES		20,250	
	22	EA	INDICATOR	80	1,760	
	12	EA	MICROBASED CONTROLLER		20,000	
	1	EA	CONTROL PANEL		3,500	
			MISC.		5,790	
			200 MHRS INSTALLATION		7,700	
			TOTAL ITEM 47			130,000

PART 7

SCHEDULE


DESCRIPTION
MONTHS
1
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12
1. Contract Award
2. Project Scope
a. Engineering Review and Estimate Check
b. Client Review
3. Combustor
a. Establish Parameters
b. Determine scope of Combustor contract Re. Eng., Fab. (Subcontracts and Canadian content) Performance Guarantee and Proprietary Inf.
c. Spec. Preparation
d. Spec. Client Review and Approval
e. Spec. Out for Bid
f. Bid Review and Place P.O.
g. Eng. and Drawing Prep.
h. Dwgs. Review
i. Fab. & Delivery
4. Major Equipment
a. Data sheet preparation and identification of bidders
b. Issue Enquiries and bid period
c. Bid Evaluation and P.O. Award
d. Manufacture and Delivery of Equip.
5. Detail Design & Dwgs.
a. Mechanical
b. Electrical
c. I & C
d. Civil (Foundations and Steel)
6. Steel & Concrete
a. Purchase & Delivery
b. Erect
7. Miscellaneous Items Purchase Delivery
8. Construction Contract
a. Contract document preparation and issue for bid
b. Bid period
c. Bid review and award contract
d. Mobilization
e. Construction (See below details)
9. Existing building modifications and additions
10. Mechanical Installation mechanical equipment, combustor, ducting, piping, etc.
11. Electrical Installation MCC's, cabling, wiring, etc.
12. I&C Installation Control panels, wiring, etc.
13. Commission System

PART 8

SUMMARY AND CONCLUSIONS

8.1 SUMMARY AND CONCLUSIONS

The conceptual design, specification and budgetary estimate have been compiled using the basic data provided and proven technology. Section 3 of this report discusses various alternatives and options that were considered and the reasons for selecting particular equipment.

The following points summarize the salient features affecting the choice of methods and equipment.

811 COMBUSTOR

The Pyropower design of combustor cooling using longitudinal bayonet tubes poses a major problem in the overall height required. This method of cooling would normally be employed only on a test rig, as large scale plants would probably incorporate some form of water wall construction similar to that employed in present-day boiler units. Within the terms of reference of this study, it was not practical to redesign the combustor to obviate the need for bayonet tubes.

812 BED COOLING

The adoption of a screw feeder necessitated a small increase in the elevation of the combustor, but this choice was based on operational experience and simplicity. Some height could be saved in detailed design by adopting a combination of systems that permits lowering of the combustor.

813 LAYOUT

The layout shown on Plate 2 is based on the prescribed floor area of 6 m x 6 m. The equipment fits into this area although access stairs and platforms encroach to some extent on the surrounding areas. However, it has not been possible to accommodate all the equipment within the 10.9 m existing roof height, as bayonet tube withdrawal from the combustor precludes this. At this stage, we have recommended a roof enclosure to permit the bayonet tubes to be withdrawn and inserted as this will be a frequent operation. As the entire rig is supported independently of the building, consideration may also be given to utilizing the rig steelwork as the frame of an independent enclosure, if space and environmental factors permit this alternative.

814 MATERIALS HANDLING

The choice of the solid fuel handling system was largely dictated by the possibility of large lumps of coal being handled. If screening of this fuel is adopted, a number of alternatives are available using pneumatic/vacuum methods for both charging the coal bin and transferring the coal/limestone to the combustor. As these operations would not normally coincide, detailed design might permit the use of a single blower or, by using an eductor for the vacuum duty, eliminate a blower.

8.2 CONCLUSION

At this stage, therefore, we consider that the conceptual design has investigated a number of possible means of accomplishing the basic requirements of the rig. Factors such as methods of operation, desired investigations, and Ministry/Canmet internal requirements may modify some choices of equipment or dictate areas in which more detailed investigations/discussions will be necessary before equipment is purchased.

It is estimated that the design, supply and erection of the pilot rig would require 12 months from date of instructions to proceed.

The budgetary cost estimate for the design, supply and erection of the pilot facility detailed in this report indicates a cost of $1,280,000. This cost includes O.R.S.T., Freight and site supervision but excludes Federal taxes, tariffs and exchange rate fluctuations.

PART 9

APPENDICES

9.1 APPENDIX 1

911 WEIGHFEEDER QUOTATION

A quotation received from Merrick Scale Manufacturing Company for a coal weighfeeder and a limestone weighfeeder is attached. This alternative is not included in the conceptual design but the information is included in this appendix for future reference.

Merrick

July 7th, 1982

Monenco Ltd.,
P.O. Box 1540
ST. CATHARINES, Ontario.
L2R 7J9

Attention: Mr. Dick West

Subject: Weight Belt Feeders
Proposed Pilot Plant
Merrick Proposal A-32286

Dear Mr. West:

With reference to the subject and our recent telephone conversation, please find enclosed our preliminary proposal A-32286 for your review.

Our proposal is based on the supply of two (2) 12" Merrick Model 950 DSC-1 Weighfeeders c/w enclosures, D.C. Drive and Digital Controller.

As an alternative, we have included pricing for a 20" 950 DSC-1 in the event material flow problems may be encountered. Other considerations as vibrating bin bottoms, etc. may be reviewed with our Dave Lewis, during his upcoming visit to your offices.

Several options have also been included for your review.

Trusting the enclosed is sufficiently detailed, we look forward to working further with you in the near future.

Yours very truly
MERRICK CANADA LTD.

J.M. Reid
Vice-President &
General Manager

Enc: SS-950 Tech. 902

cc--D.E. Lewis
cc--T. Miskovich, Passaic

Merrick Canada Ltd, 494 The Queensway, Peterborough, Ontario K9J 7L9, (705) 742-9233, Telex 06-962921

FOUNDED 1908

WORLD WIDE

WEIGHTOMETER® FEEDOWEIGHT®
GRAVIMERIK®
FLOW STAR
CONTROL SYSTEMS

MERRICK SCALE MFG. CO. OF CANADA Ltd/Ltee
494 The Queensway, Peterborough, Ont. K9J 7L9
TELEPHONE (705) 742-9233 • TELEX 06-962921

TO: Monenco Ltd.,
P.O. Box 1540
ST. CATHARINES, Ont.
L2R 7J9
Attn: Mr. Dick West

DATE: July 7/82
YOUR REFERENCE: Pilot Plant
PROPOSAL NO.: A-32286

WE PROPOSE TO FURNISH THE EQUIPMENT LISTED BELOW, AT THE PRICES SHOWN, F.O.B. FACTORY, PETERBOROUGH, ONTARIO, SUBJECT TO THE TERMS AND CONDITIONS INCLUDED HEREIN AND PRINTED ON THE REVERSE SIDE OF THIS PAGE.
PROPOSAL SUBJECT TO ACCEPTANCE WITHIN 30 DAYS.

ITEM NUMBER	QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL PRICE
1	2	12" **MERRICK MODEL** 950 DSC-1 Weighers DESIGNED IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS: CAPACITY: 150 to 650 #/Hr MATERIAL: Coal & Limestone DENSITY: 55 #/Ft^3 90 #/Ft^3 SIZE: - 1/2" - 1/2" MOISTURE: 3-4 % Surface TEMPERATURE: To 150°F Max. CHARACTERISTICS: Free Flowing FEEDER LENGTH: Standard DRIVE: 1/4 H.P. D.C. ACCESS SIDE: To be advised POWER REQUIRED: 115 VAC ± 10% 60 Hz. STANDARD EQUIPMENT EQUIPMENT SUPPLIED BY OTHERS REFER TO: Specification Sheet 950 ACCURACY: ± 0.5% of Set Rate over a 20:1 range, when installed and maintained in accordance with our recommendations.		

Shipment
Drawings ________________ After receipt of complete data.
Equipment ________________ After receipt of approved drawings.
c.c.

TERMS: NET 30 DAYS
MERRICK SCALE MFG. CO. OF CANADA Ltd/Ltee

FORM # 141C

REFERENCE: Pilot Plant
PROPOSAL # A-32286
DATE: July 7/82

ITEM NUMBER	QUAN.	DESCRIPTION	UNIT PRICE	TOTAL PRICE

STANDARD EQUIPMENT

A. Self-Contained Belt Feeder, Including:

1. Cantilever CRS feeder frame designed to permit quick replacement of feeder belt and complete removal of the feeder for maintenance. Frame is supported by 304 SS support rods. Standard enclosures are included.
2. Crowned aluminum conveyor head and tail pulleys.
3. Belt - precision woven endless, polyester, black neoprene coated rated at 250°F (120°C).
4. 304 SS slider bed support decks.
5. 304 SS full length skirtboards designed for quick removal.
6. 304 SS infeed with insert (square).
7. 304 SS shear gate - manually adjusted.
8. 304 SS feed cutoff gate.
9. 304 SS metal blade scrapers at belt discharge, inside belt and tail pulley.

B. Weight Transducer System, Including:

1. Precision milled aluminum weighdeck.
2. Precision strain guage load cell with overload protection.

C. Speed Pickup:

Model 950 - DSP-1 solid state digital sensor mounted in NEMA 1 enclosure off drive motor.

D. Motor (Side Mounted):

1/4 H.P. DC Motor (TENV), directly coupled to head pulley, including suitable reducer, right angle drive, couplings, guards, and FSC-4C motor speed controller (SCR) mounted in separate NEMA 12 enclosures.

ITEM NUMBER	QUAN.	DESCRIPTION	UNIT PRICE	TOTAL PRICE
		E. Test Chain - for calibration.		
		F. DSC-1 (Model 950) Digital Feed Control System (S/S 850)		
		1. 4 digit thumbwheel switch for setting rate. 2. "High" and "low" alarm contacts and lights. 3. Proportional band and reset adjustment. 4. 0-5 MA DC controller correction output signal. 5. 4 digit L.E.D. digital "rate", "weight" & "speed" display. 6. 8 digit L.E.D. totalizer - resettable. 7. Analog "rate" output signal. 8. Digital output signals. 9. Panel mount or wall mount enclosure.		
		G. EQUIPMENT SUPPLIED BY OTHERS:		
		1. "Start-Stop" pushbuttons (Model 950 DSC) 2. AC motor starter (Model 951 DS) 3. "Power" disconnects. 4. Feed hopper. 5. Supports other than specified. 6. Discharge chutes. 7. Wiring between remote and local instruments. 8. Stepdown transformers or isolation converters.		
		PRICE:--	$10,986.00	
		ALTERNATIVE:		
		In the event a 20" 950 DSC-1 wide unit is required to ensure proper operation of the feeder with varying material sizing and moisture content, you may wish to consider		
2	2	20" Merrick 950 DSC-1 Engineered and Designed to the same specifications		
		PRICE:-------------------------------- Each	$12,455.00	

REFERENCE: Pilot Plant
PROPOSAL # A-32286
DATE: July 7/82

ITEM NUMBER	QUAN.	DESCRIPTION	UNIT PRICE	TOTAL PRICE
		OPTIONS:		
3	2	Explosion Proof Load Cell Assembly to meet Class 11, Division 1, Group E,F & G operation requirements and includes: 1) - NEMA 9 Junction Box 2) - Hermetically sealed load cell.		
		PRICE:--------------Each-------------------- $	686.00	
4	2	1/4 H.P. D.C. Explosion Proof Motor for Class 11, Division 1, Group E,F & G Operation		
		PRICE:--------------Each-------------------- $	808.00	
5	2	DSP-3 Solid State Digital Speed Sensor in an explosion proof housing		
		PRICE:--------------Each--------------------$	484.00	
		....		
		Installation Service per attached form.		
		....		
		Drawings - 2 - 3 Weeks ARO		
		Equipment - 8 - 10 weeks after receipt of approved drawings.		
		Enc: SS-950 146C		
		cc--D.E. Lewis cc--Merrick, Passaic, T. Miskovich		

3 sizes to fill your needs from 1 oz./minute to 100,000 lbs./hr.

950C 12" and 20" Sizes

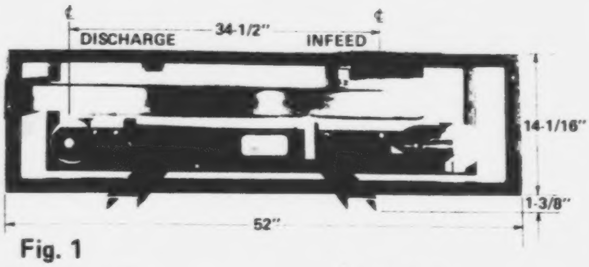


Fig. 1

OPEN TYPE

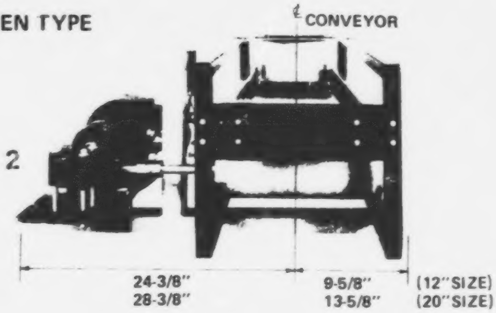
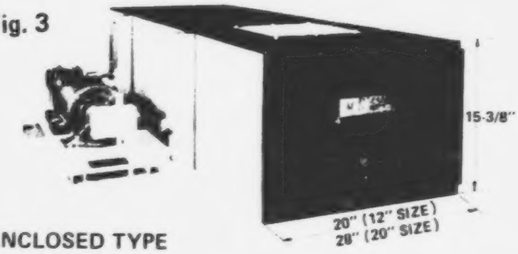


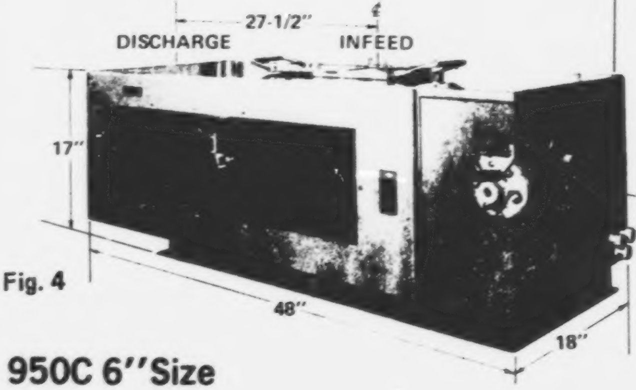
Fig. 2

Fig. 3



ENCLOSED TYPE

SIZE	Infeed Opening	Discharge Opening	Width Overall	Infeed To Discharge
6"	5-5/8"x5-5/8"	6"x8"w.	18"	27½"
12"	7-5/8"x7-5/8"	9"x14"w.	34"	34½"
20"	13-3/4"x13-3/4"	9"x22"w.	42"	34½"



DC Permanent Magnet Type Gear Motor – 1/6 HP – Isolated from the Material Flow Chamber.

Fig. 4

950C 6" Size

CAPACITY (Based on 100 lb./cu. ft. material).	6" (152mm)	12" (305mm)	20" (508mm)
Minimum/minute Maximum/minute	1 oz. (23 g.) 100 lbs. (45 kg.)	1 lb. (454 g.) 1200 lbs. (546 kg.)	1 lb. (454 g.) 1500 lbs. (680 kg.)
Maximum LUMP size	5/16" (8mm)	1/2" (12mm)	3/4" (20mm)
WEIGHT with Enclosure	350 lbs. (160 kg.)	350 lbs. (160 kg.)	400 lbs. (182 kg.)

STANDARD EQUIPMENT – 950 C

A. Self-Contained Belt Feeder, Including:
1. Cantilever feeder frame designed to permit quick replacement of feeder belt and complete removal of the feeder for maintenance. Supported by 304 SS support rods.
2. Crowned aluminum conveyor head and tail pulleys; except on 6" size which has a rubber lagged tracking type.
3. Precision endless woven belt. Dacron carcass, black neoprene impregnation. Rated at 250 degrees F. (121 degrees C.).
4. Slider bed support decks – 304 SS.
5. Full length 304 SS quick removal skirtboards; except on 6" size which has no skirtboards.
6. Infeed throat with suitable insert – 304 SS.
7. Manually adjusted 304 SS material shear gate.
8. Double handled 304 SS material feed cut-off gate.
9. Metal blade scrapers – 304 SS at belt discharge, return side belt and tail pulley.

B. Weight Transducer System Including:
1. Precision milled aluminum weigh platform.
2. Precision strain guage load cell with overload protection.

C. DSP Speed Pickup, digital, solid-state, in enclosure mounted to feeder drive motor.

D. DSC Digital Feed Control System (S/S 850)
Panel or NEMA IV housing, (Remote)

E. Variable Speed Drive, Including:
1. Direct coupled 1/4 HP DC motor, reducer and coupling guard.
2. FSC-4C SCR DC motor speed controller, (Remote).

F. Test Chain – For Calibration

G. Power Required – 115V/230V ± 10%,
Single Phase, 50/60 HZ

H. Accuracy:
Plus or minus 0.5% of set rate @ 2 sigma.

I. Ambient Temperature Limits – 15°F. to 170°F.
(-26°C. to 77°C.)

9.2 APPENDIX 2

921 MATERIALS CONVEYING AND WEIGHING SYSTEMS

A quotation received from Control and Metering Limited is attached, for:

- Coal Weighing and Feeding System
- Limestone Weighing and Feeding System
- Limestone Filling System
- Ash Reinjection System
- Bed Drain Cooler
- Bed Residue Transport System

The bed drain cooler pricing is used in the conceptual design but the remaining material is included as alternatives for future reference.

Control and Metering Limited

711 Kipling Avenue, Toronto, Ontario, M8Z 5G4,
Telephone: 259-8411, Telex: 06-967647

QUOTATION

To Montreal Engineering Company Limited
One St. Paul Street
P.O. Box 1540
St. Catharines, Ontario
L2R 7J9

ATTEN: Mr. R.P. West
Project Manager

Date August 20, 1982

Quotation No. 112-82-740-JB

Your Reference Canmet A.R.F.B.C. Pilot Plant

Dear Sir:

As requested, please find below our budget quotation for the supply of systems as indicated on your request of July 12.

We sincerely apologize for the delay in getting this information to you and hope we have not thrown off your schedule.

(A) Coal Weighing and Feeding: Fox Feeder

Please refer to your data sheet filled in and attached.

System includes:

- 42 cuft. hopper
- outlet valve
- flex connection
- helix feeder
- load cell and readout
- scale platform
- SCR drive
- feeder outlet connections
- controls and control panel

TOTAL BUDGET PRICE: THIRTY THOUSAND DOLLARS ------------------------$30,000.00

(B) Lime Weighing and Feeding: Fox Feeder

See data sheet.

System includes:

- 23 cuft. hopper
- outlet valve
- flex connection
- helix feeder
- load cell and readout
- scale platform
- SCR drive
- feeder outlet connections
- controls and control panel

cont'd page 2

(B) Lime Weighing and Feeding: Fox Feeder (Cont'd)

TOTAL BUDGET PRICE: THIRTY THOUSAND DOLLARS ------------------------$30,000.00

(C) Limestone Filling System: Transvac

See data sheet.

Transvac TR500 System complete with:

- 12 cuft. transfer hopper
- 16 H.P. vacuum pump assembly
- inlet filters
- pick-up wand
- all necessary tubing
- air logic control panel
- air control valve

Control panel requires 5 cfm. at 70 psi.

TOTAL BUDGET PRICE: TWENTY-ONE THOUSAND FIVE HUNDRED DOLLARS -------$21,500.00

(D) Ash Rejection System: Transvac

Transfac TR300 System complete with:

- 5 cuft. transfer hopper
- venturi power unit
- inlet filters
- pick-up wand
- all necessary tubing
- air logic control panel

TOTAL BUDGET PRICE: THIRTEEN THOUSAND FIVE HUNDRED DOLLARS ---------$13,500.00

(E) Bed Drain Cooler: Porcupine Processor

Bethlehem Porcupine Processor Model 1P1203 c/w 2 H.P. drive.

See attached brochure for details and data sheet.

TOTAL BUDGET PRICE: FORTY THOUSAND FIVE HUNDRED DOLLARS ------------$40,500.00

(F) Bed Residue Transport: Transvac

Transvac TR300 System as in (D) above.

TOTAL BUDGET PRICE: THIRTEEN THOUSAND FIVE HUNDRED DOLLARS ---------$13,500.00

cont'd page 3

Terms and Conditions

Federal and Provincial Sales Taxes Extra.
F.O.B. our Toronto Plant.
Delivery: 14 - 16 weeks.
Terms: 100% Net 30 Days.

Please find dimensional data and general equipment outlines as requested. We look forward to working with you on this project and thank you for your interest in our firm.

Yours very truly,

CONTROL AND METERING LIMITED

Jeff B

Jeff Bowers
Process Engineering and Sales

JB/fs

Encl.

DATA SHEET

BED RESIDUE TRANSPORT

Material: Bed Residue (Limestone & Ash)

Flowrate: Max. 350 lb/hr
Min. 15 lb/hr (est)

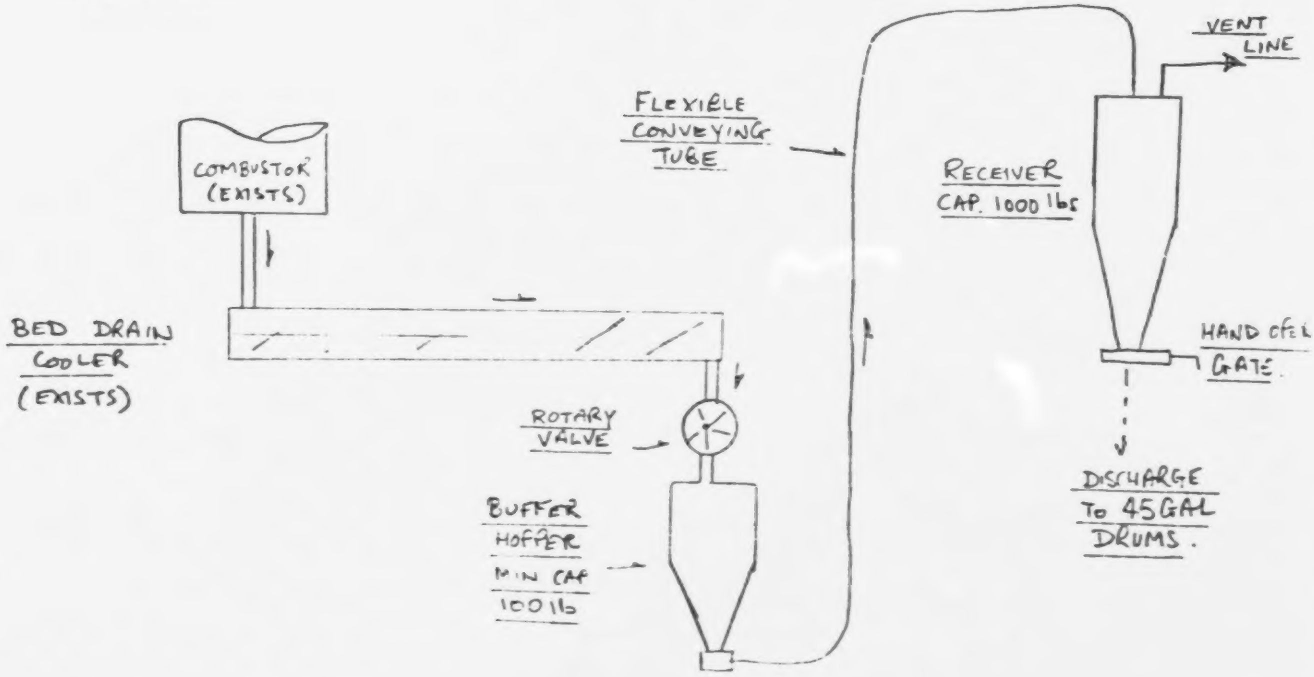
Particle Size: -½"

Temperature: 300°F

Source: Collector below Bed drain cooler

Operation: Intermittent

Diagram:


COMBUSTOR (EXISTS)
BED DRAIN COOLER (EXISTS)
ROTARY VALVE
BUFFER HOPPER MIN CAP 100 lb
FLEXIBLE CONVEYING TUBE
VENT LINE
RECEIVER CAP. 1000 lbs
HAND OPER GATE
DISCHARGE To 45 GAL DRUMS.

R.P.W
12-7-82

DATA SHEET

BED DRAIN COOLER

Material:	Bed Residue (combination of limestone & ash)
Bulk Density:	90 lb/ft^3
Temperature:	1600°F
Flow Rate:	Max. Normal - 358 lb/hr
Flow Rate:	Min. Normal - 15 lb/hr (estimated)
Particle Size:	Minus ½ inch
Speed Control:	Variable Speed Drive
Cooling Medium:	Municipal Water
Supply Temperature:	80°F
Max. Outlet Temperature:	150°F
Supply Pressure:	30 psig
Required Bed Residue Outlet Temperature:	300°F
Speed Range:	* RPM 10-30
Required Water Flowrate:	* USGPM [illegible] [illegible] 47 - [illegible]
Motor Horsepower:	* H.P. 2 HP
Electrical Power Required:	* V [illegible]
Unit Dimensions:	* [illegible]4" x [illegible]" x [illegible] FT
Screw Diagram:	* Inches [illegible]"

Please complete items marked *

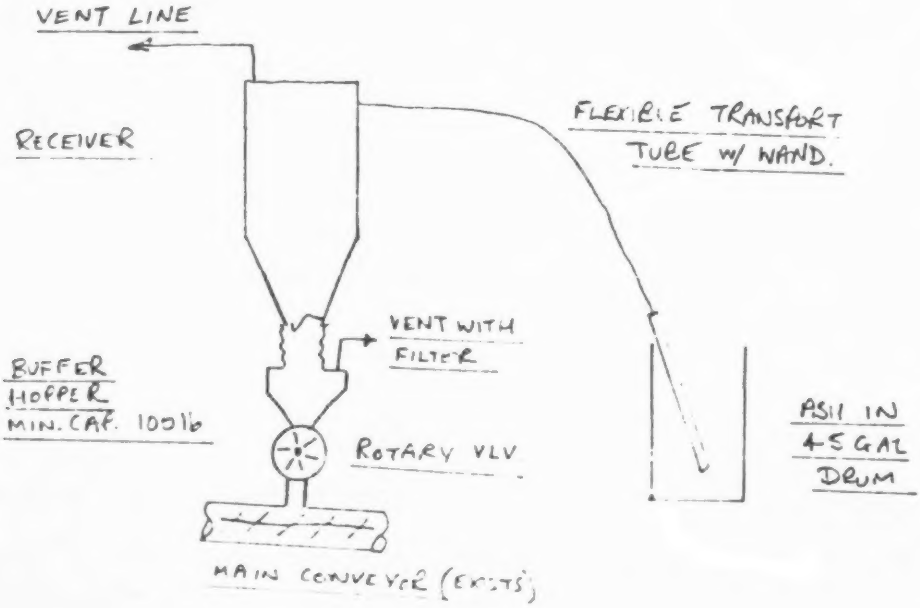
RPW
12-7-82

DATA SHEET

ASH REJECTION SYSTEM

Material:	Flyash
Flowrate:	Max. 200 lb/hr
Size:	98% <20 microns
Source:	45 gal. drum
Operation:	Intermittent
Height:	10m
Distance Total:	15m

Diagram:


VENT LINE
RECEIVER
FLEXIBLE TRANSPORT TUBE W/ WAND.
VENT WITH FILTER
BUFFER HOPPER MIN. CAP. 100lb
ROTARY VLV
ASH IN 45 GAL DRUM
MAIN CONVEYOR (EXISTS)

RPW

DATA SHEET

LIMESTONE FILLING

Material:	Limestone
Size:	-½"
Bulk Density:	90 lb/ft^3
Flowrate:	6000 → 8000 lb/hr
Purpose:	To prefill limestone bin prior to combustion test of rig.
Source:	45g. Barrel
Height:	10m
Hose Length:	15m (est.)
Motor H.P.	* [illegible]
Line ~~Lime~~ Sizes:	* inches - VAC [illegible] 4" [illegible] 3"
Receiver Dimensions(DIA/ Height):	* ft. [illegible] HEIGHT

Please complete items marked*

RPW

DATA SHEET

COAL/LIMESTONE WEIGH MEASUREMENT AND FEEDERS

Material:	COAL	LIMESTONE
Size:	Max. 2" (<1%) Min. < 100 Mesh	-¼"
Flowrate:	Max. 660 lb/hr (13 cuft/hr) Min. 35 lb/hr	Max. 125 lb/hr 1.4 cuft/hr Min. 10 lb/hr
Bin Size:	2000 lb (40 cuft)	2000 lb 22 cuft
Isolation Vlv. on Bin Inlet:	✓	✓
Bulk Density:	50 lb/ft^3	90 lb/ft^3
Continous Feed/ Variable S.P.:	✓	✓
Motor:	* H.P. (Ex. Proof) 1/4	* H.P. 1/4
Back Pressure:	35" W.G.	35" W.G.
System Weight Full:	* lb approx. 4000	* lb approx. 3600
Dimensions (LXWXH):	* ft 5×5×15 approx.	* ft. 5×5×9 approx.
Electrical Power Supply:	* V. 115/1/60	* V. 115/1/60

Please complete items marked*

RPW

9.3 APPENDIX 3

931 COAL AND LIMESTONE WEIGHING AND FEEDING

Attached is a quotation from Peacock Inc. offering Thayer "LWF" loss-of-weight systems for both coal and limestone weighing and feeding. This material is not included in the conceptual design but is included for future reference.

PEACOCK INC

QUOTATION NO. T82-425

CORRESPONDENCE RELATING TO THIS QUOTATION SHOULD BE MAILED TO:-

1180 Aerowood Drive,
Mississauga, Ontario.
L4W 1Y5
Phone: (416) 625-7100

August 18, 1982.

Montreal Engineering Co. Ltd.,
P. O. Box 1540,
St. Catharines, Ontario.
L2R 7J9

Attention: R. P. West

Subject: Thayer Loss of Weight Feeders

Gentlemen:

Thank you for your inquiry for 2 Thayer Weigh Feeders.

For your application, we recommend the Thayer "LWF" Loss-of-weight Feeder which was selected because of the following operational features:

- Patented Thayer Cable Scale Suspension System which is self-aligning to gravity and is immune to building strains and ambient vibration.
- Thayer Model LC-137 Load Cell which produces a high level weight signal and is equipped with 1000% overload protection.
- Thayer Model IFC-133 LWF Digital Controller eliminates controller drift as well as need for periodic calibration.

The proposed equipment is generally illustrated in the enclosed bulletin #LWF-82-5K.

Thank you for the opportunity to submit our proposal. We look forward to working with you on this project and to demonstrating the reliability of our equipment.

Yours very truly,
PEACOCK INC.

R Knox

RK/dk

R. Knox

SPECIFICATIONS:

NO. REQUIRED:	1	1
MODEL #:	LWF-V-5-150-MS	LWF-V-15-660-MS
MAX. CAPACITY:	150 lb/hr	659 lb/hr
MATERIAL:	Limestone	Coal/fluid coke
DENSITY:	90 PCF	55 PCF
PARTICLE SIZE:	1/8 - 1/4"	1/4 - 2"
MOISTURE:	Dry	2 - 20%
TEMPERATURE:	40 - 100° F	40 - 100° F
CHARACTERISTICS:	Dusty	Dusty
HOPPER CAPACITY:	5 cu. ft.	15 cu. ft.
RUN CYCLE	60 min.	45 min.
FILL CYCLE	30 sec.	30 sec.
ACCURACY	1/10 - 1/2% to be determined by tests	

EQUIPMENT:

Equipped With Vibratory Pan Discharge

SCR CONTROLLER: NEMA-12 Enclosure including the following:

- Adjustable current limiting
- IR Compensation
- Minimum and maximum speed adjustment
- Transient voltage protection
- Isolated input circuit for accepting 1-5, 4-20, or 10-50 MA remote control signal
- AC starting
- Isolation transformer

continued ....

HOPPER: Constructed of carbon steel

HOPPER COVER: By others.

SCALE: Thayer Scale uses a unique scale system consisting of a special patented cable suspension system and LVDT type load cell that is self-aligning to gravity and unaffected by building strains, shock loads and vibration.

CABLE SUSPENSION LEVER SYSTEM:
Using Stainless Steel prestressed aircraft cable, the weigh hopper and screw feeder assembly is suspended from four points by a summing lever system that transduces the total load to a single load cell. The dead load is mass counterbalanced to insure 100% utilization of the load cell range.

LOAD CELL:

Thayer Model LC-137
Linear Voltage Differential Transformer:
Output signal: 0-800 mV DC
Temp. Co-eff: ± 1.001%/°F
Linearity: ± .05% Full Scale
Deflection Element: Isoelastic element
Overload protection: 10,000 #
Temperature compensated.

INSTRUMENTATION: Thayer Model IFC-133 LWF Integrator/Controller:

The function of the integrator controller is to measure the weight loss differential from the scale load cell and to integrate the weight loss change with respect to time and to provide a digital rate signal to a frequency based digital controller.

continued ....

The IFC-133 LWF Controller contains the following components and features:

- Rate Indicator - Calibrated in engineering units.
  Set Point Indicator - Calibrated in engineering units.
- Output Signal Indicator - 0-100%.
- Hopper Weight Display indicating material remaining in hopper - calibrated in Lbs. - 8 decade.
- Auto-Man Switch and Manual Adjust Potentiometer.
- Manual Mode Indicating Light.
- Digital Thumbswheel Setpoint - 4 decade.
- Remote Setpoint Indicator Light.
- Ratio Setpoint Indicator Light.
- Direct Setpoint Indicator Light.
- Volumetric Mode Indicator Light.
- Fill Cycle Indicator Light.
- Speed Alarm Indicator Light.
- Deviation Alarm Indicator Light.
- Memory Capability.

Signal outputs available:

Analog Rate:	Any one of the following signals are available: 1-5, 4-20, or 10-50 MA DC.
Digital Weight:	24 Volt DC pulses Contact Closure
POWER REQUIRED:	115 VAC/± 15%/50-60 Hz 0.5 Amps

EQUIPMENT SUPPLIED BY OTHERS:

- Wiring and Cables
- Installation
- Remote instrumentation other than specified
- Feed Cutoff Gate

continued ....

PRICING SUMMARY

1 only Thayer Model LWF-V-5-150-MS
Loss of Weight Feeder for Limestone c/w vibratory tray discharge

Price each --- $30,223.00

1 only Thayer Model LWF-V-15-660-MS
Loss of Weight Feeder for Coal/fluid coke

Price each --- $30,626.00

FOB	LaSalle, Quebec
TERMS	Net 15 days
TAXES	Extra
ACCEPTANCE	Within 30 days
DELIVERY	14-16 weeks after approved data

Yours very truly,
PEACOCK INC.

R. Knox
R. Knox

RK/dk

cc E. Yanoshita

POOR

QUALITY

ORIGINAL